REVISION NOTES ON PRINCIPLES OF SURGERY

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FOREWORD

There has been a marked change in the requirement for the Part II surgical examination recently. Gone are the days when candidates could concentrate on a "long case" presentation, "short case" assessment and a "viva" to confidently appear for the examination. It is now essential for all trainees to understand and apply the "science of surgery" to clinical practice. It is this concept that has created the surgery in general examination for the M. Med and FRCS.

This collection of notes the two editors have compiled is timely for the postgraduate student preparing for his examination. It deals in a clear and didactic manner the principles of surgery in general. The format should enable the well read student to organise his thoughts and systematise his knowledge. These notes will undoubtedly form an excellent basis for revision.

I am sure the postgraduate trainee is going to find these notes extremely useful. The editors are to be congratulated in their effort. I am sure it is going to be in great demand.

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PREFACE

This effort represents our collection of notes for the Part B and C of the FRCS examinations. As such, there is no attempt to be comprehensive or to cover subjects that are dealt with extensively in the standard surgical textbooks.

The format is geared towards a systematic approach to questions in the Principles of Surgery section of the surgical fellowship examinations. Hence they have been conveniently divided into major headings and subheadings for ease of recall and presentation in the examination hall. Principal points are also highlighted. We have attempted to make our approach as clinical as possible.

These notes are not meant to be a replacement for any surgical textbook, but rather a supplement to the standard textbooks. To obtain maximum benefit, the reader should have already gone through his basic reading. These notes serve as a quick revision.

Although written with the surgical trainees in mind, we believed the general principles outlined in this book will be beneficial to the medical students preparing for the surgical final MBBS examinations as well as nurses doing their post-basic surgical nursing course.

We like to thank our panel of reviewers who have provided invaluable comments and suggestions in their respective area of specialty. We would like to record our appreciation for the feedback from our surgical trainees and their numerous suggestions.

Low Cheng Hock
Tan Peng Kok
October 1993

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PRE-OPERATIVE MANAGEMENT

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1.2 Diabetes Mellitus and Surgery
1.3 Surgery in Neonates
1.4 Surgery in the Elderly
1.5 Surgery in Immunodeficient States
1.6 Consent
1.7 Pre-operative Skin Preparation
1.8 Prophylaxis Against Wound Infection

1.1 PREOPERATIVE PREPARATION

Objectives :

1. Optimise patient's condition for surgery and anaesthesia.
2. Psychological preparation of patient for surgery.
3. Facilitate measures to reduce postoperative complications.

Measures :

1. Assessment of operative risks (surgical and anaesthetic) and review of surgical options

   Patient-related risks (ASA Classification)
   Procedure related risks

2. Correction of deficiencies: nutritional, blood volume, fluid and electrolytes and coagulation.
3. Adequate explanation of nature of procedure and complications (informed consent).
4. Institution of prophylactic measures against common post-operative complications.
5. General preparation for surgery e.g. overnight fast
6. Specific preparation for certain procedures e.g. bowel cleansing for colonic surgery.
7. Resonable estimate of blood requirement.
8. Anticipation of likely post-operative course and need for intensive care facilities.

CONSIDERATIONS FOR HIGH-RISK PATIENTS :

1. Coronary Arterial Disease :

A. Acute Myocardial Infarction :

Risk of post-op AMI in general population - 0.5%

Risk of post-op reinfarction in patients with AMI > 6 months - 6%

Risk of post-op reinfarction in patients with AMI < 3 months - 30%

Risk of post-op reinfarction in patients with AMI 3 - 6 months - 15%

Risk of mortality with post-op AMI - >60%

- **Elective surgery should be delayed for at least 6 months after an acute myocardial infarction**
- **If early surgery required, full cardiac evaluation including coronary angiography recommended. If necessary, perform coronary arterial bypass surgery prior to the surgical procedure.**
- **Intensive peri-operative cardiac monitoring required.**

B. Angina Pectoris :

New York Heart Association classification.

I. Angina with strenuous exercise

II. Angina with moderate exercise

III. Angina after climbing one flight of stairs or walking 1-2 blocks

IV. Angina with any activity

- **Elective surgery permitted in patients with Class I and II severity.**
- **Class III and IV - Angiography and coronary bypass surgery may be necessary before major elective surgery.**
- **Prognostic Index Decribed : Goldman Cardiac Risk Index**

2. Cardiac Failure

Poor outcome in those with uncontrolled congestive cardiac failure.

- **Optimise cardiac failure first with inotropes**
- **Close perioperative monitoring of ventricular function**

3. Valvular Heart Disease

Operative risk relates to the degree of resultant cardiac dysfunction

Problem of associated cardiac arrhythmias

Risk of subacute bacterial endocarditis

Problem of anti-coagulant therapy for prosthetic valves and those with atrial fibrillation

- **Administer appropriate prophylactic antibiotics**
- **Reversal of anti-coagulation : convert to heparin one week prior to surgery and then stop heparin day before surgery. Restart heparin on second postoperative day when bleeding has ceased. Reinstitute warfarin therapy while tapering off heparin.**
- **Monitor and treat perioperative cardiac arrhythmias and cardiac failure.**

4. Hypertension

Risk of post-operative mortality for severe uncontrolled hypertension is 30% (mainly from cardiac failure).

- **If diastolic blood pressure > 110 mmHg, elective surgery should be deferred until the blood pressure is stabilised.**

5. Pulmonary Disease

Most important pathology is chronic obstructive lung disease.

Mandatory investigations : Chest X-ray

Lung function tests

Arterial blood gas

Useful tests for assessing risks of post-operative morbidity are FEV_1 (forced expiratory volume in 1 sec)and arterial blood gas analysis.

Thoracic and upper abdominal surgery makes effective coughing difficult thereby posing a greater problem in these patients.

- **Vigorous prophylactic chest physiotherapy pre- and post-operatively.**
- **Stop smoking at least 2 weeks before surgery.**
- **Those with chest infection and bronchospasm would require pre-operative hospitalisation for antibiotics, expectorants and bronchodilators.**
- **Those with acute respiratory infection should have recovered for at least two weeks before surgery.**
- **Severe chronic obstructive lung disease with uncompensated acidosis should have elective procedures postponed.**
- **Patients with severe airway obstruction (FEV_1 < 1 litre) will require postoperative ventilatory support for 36 - 48 hours.**

6. Nutritional Deficiencies

Reported incidence of more than 50% in surgical patients.

Relationship to post-operative morbidity is complex but is now well established that malnutrition increases post-operative morbidity and mortality.

Weight Loss > 20% - mortality increases by 10-20 times.

- **Pre-operative parenteral nutritional support indicated in :**
  1. **Serum Albumin < 3 g/dl**
  2. **Unintentional weight loss of > 10 % of usual body weight.**
  3. **Skin test anergy.**

- **Pre-operative nutritional support should be 30 - 45 kcal/kg/d and 1.2 - 1.5g protein/kg/d for at least 7 - 10 days.**
- **Prognostic Index Described : Prognostic Nutritional Index by Mullen.**

7. Elderly Patients

Patients above 70 years old have 4 - 8 times increased risk of operative mortality.

Most have co-existing diseases and poor tolerance for haemodynamic changes. Functional reserves are limited.

Important to realise chronological age is not the same as biological age, hence age alone is not a risk factor.

- **Accurate and careful evaluation of cardiopulmonary status.**
- **Identification and correction of systemic diseases, nutritional and fluid deficits.**

8. Diabetes Mellitus

See section on DIABETES MELLITUS AND SURGERY.

RECOMMENDED READING

Nambiar R (1981) : Preoperative Assessment. In Burnett, W (ed) : *Clinical Science for Surgeons*. Butterworth, London.

1.2 DIABETES MELLITUS AND SURGERY

Statistically, it is said that well-controlled diabetics can be expected to have a surgical mortality similar to that of a non-diabetic patient.

Problems of Diabetes in Surgery

1. Associated end-organ pathology :

   coronary arterial disease

   diabetic nephropathy

   cardiac autonomic neuropathy

   impaired ventricular function

2. Metabolic decompensation :

   diabetic ketoacidosis

   non-ketotic hyperosmolar coma

3. Poorer wound healing :

   prone to infection

   micro-angiopathy with tissue ischaemia

   impaired energy utilisation and anabolism

4. Sepsis :

   impaired phagocytosis

   impaired killing mechanism of phagocytes

Diabetes Mellitus - Related Surgical Diseases

Peripheral vascular disease

Ischaemic heart disease

Neuropathic ulcers

Pancreatic carcinoma

Autonomic nervous system neuropathy

- impaired gut motility
- detrussor failure

Opthalmopathy

- retinopathy
- cataract

Surgical infection

- abscesses (cutaneous, deep)

Surgical Pathology Resulting in Diabetes Mellitus

Endocrine tumours

Pancreatitis, pancreatectomy

Paraneoplastic syndrome (insulin-like peptides)

Hepatic pathology

Diabetic Complication Simulating Surgical Condition

Diabetic Ketoacidosis presenting as acute abdomen

DIABETIC CONTROL FOR SURGERY AND ANAESTHESIA

NIDDM : minor procedure - omit morning dose

dextrose drip

major procedure- convert to insulin (see below)

IDDM : minor procedure - omit morning dose

dextrose drip

major procedure -

Pre-operative,

serum glucose < 6 mmol/L - SI 5U per 500mls D10%

KCL 10 mmol

if serum glucose increase to > 10 mmol/L, double SI dose

Post-operative,

BSL > 6 mmol/L - SI 10U per 500 mls D10%

KCL 10 mmol

if BSL increase to > 10 mmol/L, SI 15U instead

> 20 mmol/L, SI 20U instead

if BSL decreases to < 5 mmol/L, SI 5 U instead

[Alberti & Thomas (1979)]

- **List patient early in the operating list.**
- **Better to run the patient slightly hyperglycemic than risk hypoglycemia during surgery.**
- **Close peri-operative monitoring (before surgery, then hourly and at least 3 hours after the last insulin dose.)**
- **Aim for blood sugar level of 100 - 250 mg/dl.**
- **Look out for diabetic ketoacidosis in IDDM and non-ketotic hyperosmolar coma in NIDDM.**

Continue insulin until patient is taking orally, then convert to their individualised maintenance regime.

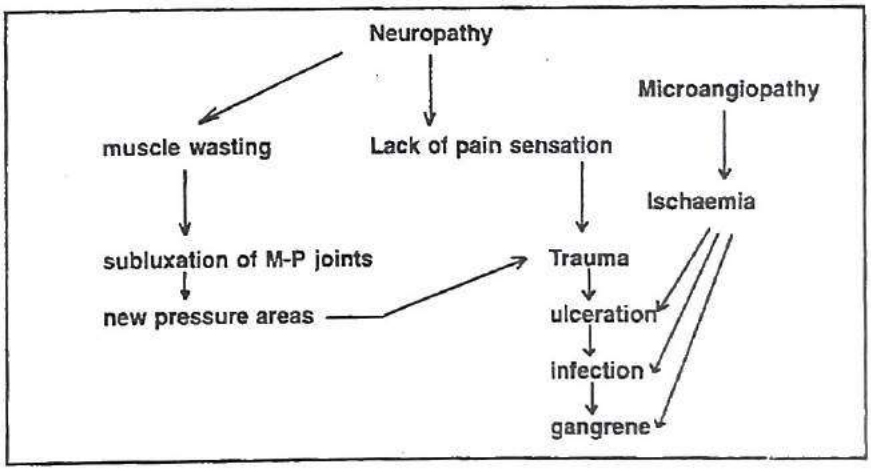
- **Maintain blood sugar level 150 - 250 mg/dl.**
- **Intravenous insulin 1U will lower blood glucose about**
  - **14 mg/dl when below 250 mg/dl.**
  - **28 mg/dl when above 250 mg/dl.**
- **When in doubt, underestimate SI requirements rather then over-estimate in order to avoid the more serious threat of hypoglycemia.**

THE DIABETIC FOOT

TWO main problems :

1. Angiopathy - atherosclerosis of large vessels
   - arteriolosclerosis of small vessels
2. Neuropathy - motor nerve involvement causing change in gait
   - sensory nerve involvement predisposing to unprotected painless trauma
   - autonomic nerve involvement with resultant dry skin and cracks

- **These problems then result in ulceration of the foot which subsequently develops secondary infection.**
- **The decrease in resistance to sepsis further compounds the problem.**



Grading Of The Diabetic Foot

Grade 0 - multiple foot deformities

- hypoaesthesia or hyperaesthesia (sensory neuropathy) may be present
- intact skin

Grade 1 - superficial ulcer involving skin only

Grade 2 - deeper ulcer that includes tendon, bone, ligament, or joint

Grade 3 - still deeper ulcer that includes abscess and/or osteomyelitis

Grade 4 - gangrenous area of some portion of forefoot

Grade 5 - foot is gangrenous over the greater percentage of the foot

Principles Of Management

A. Prophylaxis - foot care
patient education

1. daily inspection of accidental damage to feet
2. foot hygiene, socks, stockings
3. footwear should be well fitting with soft and pliable uppers
4. nails should be cut transversely at the centre
5. corns and callosities should be treated by a chiropodist
6. abstain from smoking which can aggravate arterial disease process
7. never walk bare-footed

B. Improving Arterial Inflow (vascular reconstrucion)

* useful only if there is significant inflow obstruction

* preoperative assessment would include ankle/brachial index, exercise testing, duplex ultrasound, digital subtraction angiography

* procedures include arterial bypass, laser angioplasty, balloon angioplasty

C. Local Surgery

Grade 0 - corrective surgery for deformities to relieve pressure over potential breakdown areas if conservative measures (eg tailored shoes and pressure relief inserts) are inadequate

Grade 1 - skin grafting + / - correction of bony deformities

Grade 2 - almost always need surgical debridement; after healing to a grade 0 foot, any deformity can be treated accordingly

Grade 3 - wide surgical debridement + / - local amputation

Grade 4 - if ischaemic index is > 0.45 and gangrene is dry and limited to distal portion of toe, local amputation would suffice

if gangrene is wet and progressive, ray amputation would be required

if ischaemic index has not been high enough for distal amputation, then below-knee, through-knee, or above-knee, amputation would be indicated as determined by clinical tests eg.crystal thermography,trancutaneous pO_2

Grade 5 - local procedures not adequate

below-knee, through-knee or even above-knee amputation as indicated by vascular status

1.3 SURGERY IN NEONATES

PHYSIOLOGICAL CONSIDERATIONS

Neonatal organ systems are immature and hence their funcional reserves are limited. However their capacity for growth and regeneration is considerable, unlike the failing systems in the elderly.

Thermoregulation

Tendency towards hypothermia because

1. *large surface area : weight ratio*
2. *poor vasomotor control of surface blood vessels to regulate the loss of heat*
3. *no shivering response to cold in order to generate heat by involuntary muscular activity.*
4. *central thermoregulatory responses is transitory and ineffective because myelination is incomplete.*

Precautions

* nursing of sick and premature infants should be in incubators to ensure a controlled environment
* in the operating theatres, steps should be taken to reduce heat loss
  a. use warmed cleansing solutions
  b. keep ambient temperature above 25° C
  c. use warming blanket to place child
  e. warmed all intravenous fluids
  f. use overhead heaters during induction and recovery

Precautions

* beware of barotrauma when ventilating neonates, the tidal volume is small ! (25mls in a 3.5 kg infant)

* miniaturisation of ventilatory apparatus is required to limit the dead space. Normally, a third of the tidal volume is occupied by dead space. Any increase in the dead space can cause considerable respiratory compromise

* the circulation is very sensitive to hypoxia and can revert to foetal circulation rapidly (see cardiovascular system)

Renal

1. Renal function is immature

* *Glomerular filtration rate is a third that of adults*
* *Urine can only be concentrated to 800 mosm/L cf 1400 mosm/L in adults*

2. Stabilising effect of growth

With growth, there is less solutes as most carbohydrates, protein and fat are used for anabolism. However in catabolic states or when growth fails, the spill over of solutes can overwhelm the otherwise normal kidneys

Hepatic Function

1. Detoxification function, protein production and storage of glycogen is limited

Precautions

* there is a tendency towards hypoglycemia expecially when the infant is starved in preparation for surgery. The blood sugar level should be kept above 4 mmol/L

* dosages and frequency of drug administrations has to be carefully adjusted

2. Specific and non-specific immune system are not well developed.

3. Coagulation problems because of vit K deficiency and poor hepatic production of clotting factors.

CLINICAL PROBLEMS

1. Problem of Diagnosis

   Late/delayed diagnosis

   No history available

   Non-specific symptoms

2. Technical Problem

   Smaller anatomical structures

   Vital structures more liable to damage

   Some structures are hypoplastic/aplastic and hence difficult to replace/reconstruct.

3. Decreased Functional Reserve (Immature Organs)

   Stress of anaesthesia and surgery (see above)

4. Fragile Neonatal Homeostasis

   Tendency towards hypothermia, hypoglycemia

   Reversal to foetal circulation when stressed

   Small circulatory volume

5. Specific Neonatal Conditions

   High index of suspicion required

   Tracheo-oesophageal fistula (TOF), congenital diaphragmatic hernia, pyloric stenosis, Hirschsprung's, exomphalos, gut atresia

   Other associated congenital abnormalities must be identified

6. Ethical Issues

   Question of value of surgery and quality of life eg. Down's syndrome with congenital heart disease.

7. Timing of Surgery

   Question of delaying the surgery to allow for maturation of organ systems, and preventing adverse effects on growth and development

   - cleft lip/palate : speech delay and impact on social development

   - congenital hip dislocation : delayed treatment results in secondary osteoarthritis

PREPARATION FOR ELECTIVE SURGERY

1. Explain to child the type of surgery if he is old enough to understand
2. Familiarise the older child with the hospital environment (hospital orientation)
3. Stay in hospital should be as short as possible, preferably on a day surgery basis. Parents should be encouraged to be around to minimise disruption to family unit
4. Operating theatre environment must be controlled (see section of Physiological Considerations)

5. Fluid and electrolyte maintenance

Water	1st 10 kg	4ml/kg/hour
	Next 10 kg	2ml/kg/hour
	Subsequently	1ml/kg/hour
Sodium	3 - 4 mmol/kg/d	
Potassium	3 mmol/kg/d	

FACTORS IMPROVING RECENT OUTCOME OF NEONATAL SURGERY

- improvement in antenatal diagnosis with better antenatal ultrasonic assessment and amniocentesis
- advances in paediatric anaesthesia
- advances in neonatal intensive care and parenteral nutrition

THE WAY AHEAD

In-utero surgery

Genetic engineering

SUGGESTED READING

MacMahon, RA (1984) : *An Aid to Paediatric Surgery.* Churchill Livingstone, UK.

Freeman, NV (1988) : Surgical Management of the Neonate. In : Giles GR, Moosa AR (eds) *Essential Surgical Practice*, 2nd edition. Butterworth, UK.

1.4 SURGERY IN THE ELDERLY

Clinical Problems

1. Delay or difficulty in diagnosis :

   * delay in seeking treatment because of relative immobility

   * signs masked eg. abdominal wall laxity and peritonitis

   * organ dysfunction can be a result of age eg. constipation

   * atypical presentation eg. septic but afebrile

2. Decreased functional reserve to counter stress of surgery, anaesthesia and disease process.

Important to remember that :

1. **Incidence of mortality and morbidity related to increased risk of associated diseases rather than age per se.**

2. **Interference with quality of life both physically and mentally may be more disastrous than death**

Postoperative Issues in the Elderly

Pneumonia

Ischaemic Heart Disease

Postoperative Confusion

Pain Control vs respiratory depression

Early nutritional support

SYSTEM REVIEW OF SURGICAL SIGNIFICANCE

Cardiovascular System

1. Increased incidence of atherosclerosis (may be subclinical).
2. Increased incidence of arrhythmia (from electrolyte imbalances and ischaemic heart disease).
3. Worse with presence of respiratory dysfunction.

Respiratory System

1. Chronic obstructive lung disease with decreased functional residual capacity.
2. Increased sensitivity to sedatives and analgesia.
3. Increased incidence of postoperative hypoxia.
4. Poor mobility leading to post-operative chest complications.

Renal

1. Decreased renal blood flow from atherosclerotic involvement of renal arteries.
2. Impaired function of distal convoluted tubules where the fine adjustments occurs.
3. Loss of functioning nephrons.
4. Renal dysfunction from systemic diseases eg. diabetic and hypertensive nephropathy.

Musculoskeletal

Decreased mobility predisposing to pulmonary infection/impairment, pressure sores and deep vein thrombosis.

Poor Healing

1. Poor elastic support of skin.
2. Slower collagen production.
3. Associated malnutrition.
4. Generalised atherosclerosis with tissue ischaemia.

Infective Complications

1. Impaired humoral and cell-mediated immunity.
2. Impaired non-specific immunity.
3. Urinary retention predisposing to urinary tract infection.
4. Poor respiratory effort predisposing to respiratory tract infection.
5. Poorer localisation of infection eg. early perforation in acute appendicitis.
6. Poorer haemostatic mechanism predisposing to haematoma and wound infection.

Haemodynamic Stress from Fluid Load

1. Poor tolerance of haemodynamic changes.
2. Homeostatic mechanism responds slower.
3. Associated renal impairment and impaired water clearance.

Psychiatric

1. Senile dementia
2. Acute delirium
3. More prone to post-surgical psychosis.

PRINCIPLE OF MANAGEMENT

1. Early surgical intervention
2. Choose surgical procedures that are minimally invasive with lower surgical morbidity
3. Optimise medical and physical status preoperatively
4. Early post-operative mobilisation and rehabilitation
5. Psychological support
6. Encourage nutrition

1.5 SURGERY IN IMMUNODEFICIENT STATES

Definition

Conditions in which there is an inability to mount a normal immune response against infectious agents. It can be congenital or acquired. IMMUNOSUPPRESSION refers to the artificial prevention or diminution of the immune response.

Types of Immune Response

1. Humoral - Mediated by "B" lympocytes. Effector agents are antibodies.

2. Cellular - Mediated by "T" lymphocytes. There are 2 main subgroups: T-helper cells (CD3+CD4+phenotype) and cytotoxic T-lymphocytes (CD3+CD8+ pheontypes). There are other subsets such as the natural killer cells, lymphocyte-activated killer cells and the tumour-infiltrating lymphocytes

3. Non-specific - Leucocytes, macrophages, local barrier

Etiology :

1. Congenital Immunodeficency

T-lymphocytes eg. DiGeorge's Syndrome
B-lymphocytes eg.Infantile X-linked Agammaglobulinemia
Combined B and T cells eg. Swiss-type lymphopenic agammaglobulinemia
Non-specific eg. Lazy leucocyte syndrome

2. Acquired

   - Trauma : major surgery, polytrauma
   - Metabolic : liver failure, uraemia, diabetes mellitis
   - Infective : septicaemia, HIV infections
   - Neoplastic : disseminated malignancy, reticulosis, multiple myeloma, leukaemia
   - Degenerative : elderly
   - Immunosuppression : drugs, immunotherapy and irradiation

Complications of Immunodeficent States

1. Prone to malignancy especially skin and blood
2. Prone to infection
3. Poor wound healing

Types of Predisposing Infections

Depends on which aspect of immunity affected :

Leucocytes affected (agranulocytosis)

- prone to Gram positive infections (staphylococcus and streptococcus)

Humoral immunity deficiency

- prone to encapsulated bacteria eg. pneumococcal, Klebsiella, meningococcus

Cellular immunity deficiency

- mycobacterial, viral, mycosis and protozoal infections

Problems of Diagnosis

1. Delay in diagnosis due to masking of symptoms and signs- infection with no febrile response or leucocytosis
2. Infections are usually polymicrobial
3. Cultured organisms are often also commensals, causing difficulty in their interpretations
4. Infective agents are often difficult to isolate (fastidious bacteria)
   - invasive procedures might be required eg. transbronchial washings, open lung biopsy

IMMUNOSUPPRESSION

This is commonly encountered in the clinical practice especially in this era of transplant surgery and chemotherapy for cancer.

Types Of Immunosuppression

Drugs - corticosteroids, alkylating agents, antimetabolites.

Immunotherapy - antilymphocyte serum, monoclonal antibody

Irradiation

Patients Who May Be Immunosuppressed

Rheumatic Diseases - SLE, rheumatoid arthritis, polymyositis

Respiratory Diseases - chronic bronchial asthma, chronic obstructive airways disease

Neurological Disease - myasthenia gravis

Haematological Diseases	- idiopathic thrombocytopenia, autoimmune haemolytic anaemia
Dermatological Diseases	- pemphigus, chronic eczema
Oncological Conditions	- leukaemia, lymphoma, etc
Post-transplant Patients	- renal, liver, bone marrow transplants

PRINCIPLES OF MANAGEMENT

1. In emergency surgery, beware of possible adrenal crisis in patients on chronic corticosteroid therapy

2. In elective surgery, try to reduce to the lowest possible dose of corticosteroids. Convert to intravenous form if unable to take orally

3. Strict asepsis should be observed in all procedures including dressing of wounds

4. Early and aggressive broad spectrum antibiotic coverage should be instituted when infection is suspected. Try to obtain bacteriological diagnosis and change antibiotics accordingly

5. Supportive therapy - isolation and barrier nursing granulocytes transfusions

1.6 CONSENT

Treatment or investigations carried out without the consent of the person concerned (or in the case of a child, a parent) can amount to an assault.

Informed Consent

1. Explanation to patient in non-technical language the nature, purpose and material risks.
2. Patient must be mentally sound and able to understand explanation given.
3. If insufficient information given, doctor-in-charge may be found to have breach of his duty.

Types Of Consent

IMPLIED CONSENT

when a patient comes to the doctor for treatment, the consent for physical examination is implied, but this is limited to what is reasonable and not harmful

EXPRESSED CONSENT

oral or written consent for any procedure which carries a special risk, patient's specific agreement must be obtained

ORAL CONSENT

not appropriate for major procedures; entry in clinical notes to confirm consent has been given.

WRITTEN CONSENT

documentary evidence that consent has been obtained.

Procedures Which Require Written Consent

1. all procedures requiring general anaesthesia
2. for operations other than minor ones performed under local anaesthesia
3. for potentially hazardous investigative techniques such as angiography

Obtaining Consent

1. Should be by a medical practitioner who is familiar with the details and risks of the proposed operation or investigation and can advise the patient adequately.
2. Consent should not be obtained under duress.
3. Consent should not be taken when patient under sedation or on mental-altering durgs.
4. No alterations should be made to the consent form after it has been signed by the patient. If an alternative procedure is proposed, a new consent form should be obtained.
5. Consent should not be obtained more than 2 weeks before the proposed operation.
6. If the patient's condition changes such that there is some material change in the nature, purpose or risks of the operation between the time of consent and the procedure, then a fresh consent form should be obtained.
7. Though a clause "consent to such further or alternative operative measures as may be found necessary" is usually included, this covers only what becomes necessary during the operation for the preservation of the patient's life or health. It does not allow an additional, albeit well-meaning, procedure such as removal of a sebaceous cyst.
8. If patient is unconscious and there is a genuine emergency, a doctor may safely undertake whatever treatment that is necessary to ensure

patient's life or health without a formal consent. The need for the procedure should be agreed by 2 senior doctors.

9. If the patient is below the legal age of responsibility or of unsound mind, then consent should be obtained from a guardian who is a responsible adult.

The Consent Form

* Primary purpose is to provide evidence that patient gave consent to the procedure in question which is taken with due care and formality.

* Should specify precisely the procedure envisaged.

* Should be countersigned by the medical practitioner who has explained the nature and purpose of the procedure and also countersigned by a witness who knows the hazards involved.

* Not necessary to record specific hazards, but it would be prudent to record the material risks explained to the patient in the clinical notes.

Material Risks

* In a judgement in the House of Lords, Lord Scarman ruled that a doctor's duty to warn his patient of the risks of treatment is confined to material risks.

* The question of materiality is whether in the particular situation, a reasonable person would attach significance to the risk.

* A doctor would not be liable if upon a reasonable assessment of the patient's condition, he considered that a warning would be detrimental to the patient's health.

RECOMMENDED READING

Medical Defence Union (1986) : *Consent to Treatment.* Cambridge, UK.

1.7 PRE-OPERATIVE SKIN PREPARATION

Resident bacterial flora :	*staph. aureus (some)*
	diphtheroids
	Gram -ve bacilli
	staph. epidermidis
	micrococci
Transient flora :	*staph. aureus*
	pseudomonas
	clostridia spores

Whole Body Disinfection

4% chlorhexidine gluconate soap showers on day before operation and morning of operation.

Local Antiseptic Preparation

Cetrimide	*5%*
Chlorhexidine	*0.5% with 70% alcohol*
Chlorhexidine	*0.5%*
Povidone iodine	*10%*

Effectiveness of solutions (reduction in bacteria counts) :

	1 washing	6 washings
Povidone iodine	68%	99.7%
Chlorhexidine 0.5% in 95% alcohol	97.9%	99.7%
Chlorhexidine 0.5%	65.1%	91.8%

IDEAL ANTISEPTIC

1. Rapid bactericidal action
2. Wide spectrum of activity
3. Persistent duration of action
4. Non-sensitising
5. Non-irritant

NOTES ON COMMONLY USED ANTISEPTICS

Chlorhexidine

Cationic biguanide

Microbial susceptibility :

G+ve - *highly susceptible*

G-ve - *moderately susceptible*

Spores - *resistant*

Lipophilic virus - *may be susceptible*

Hydrophilic virus - *resistant*

* Absorbed onto surface of bacteria causing decrease in negative charges on the cell leading to leakage of cystoplamic constituents and precipitation of cytoplasm

* Active in pH5.5-8.0, inactivated by soaps and other anionic detergents

* Precipitated by inorganic anions eg. chloride and sulphates

Hexachlorophene

Bisphenol

Microbial susceptibility :

G+ve - *susceptible*

Others - *resistant*

* Slow onset with low water solubility

* Accidental ingestion can cause death

Iodophors (Povidone-iodine)

Organic complexes containing iodine trapped within miceles of a surface active agent

Microbial susceptibility :

G+ve - *highly susceptible*

G-ve - *highly susceptible*

Acid-fast - *susceptible*

Spores - susceptible

Protozoan Cyst - susceptible

Lipophilic Virus - susceptible

Hydrophilic virus - susceptible

Fungi - susceptible

* Decomposes at >40°C

* Act best at neutral to acid medium

* Hypersensitivity reactions to iodine

Quarternary ammonium compounds (cetrimide)

Cationic surface active disinfectants

Microbial susceptibility

G+ve - highly susceptible

G-ve - moderately susceptible

Acid-fast - resistant

Spores - resistant

Lipophilic virus - susceptible

Hydrophilic virus - resistant

* Inactivated by protein in blood, serum and by synthetic detergent

* Less effective if pH < 7

Alcohols (ethyl alcohol, isopropyl alcohol)

Acts by protein denaturation

Microbial susceptibility :

G+ve - highly susceptible

G-ve - highly susceptible

Acid-fast - susceptible

Spore - resistant

Lipophilic virus - susceptible

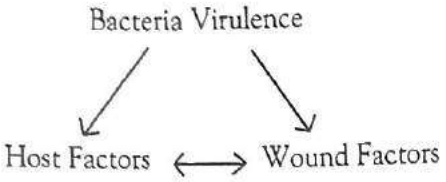
Hydrophilic virus - resistant

* Alcohol concentration decreases with evaporation

* Irritant and toxic

1.8 PROPHYLAXIS AGAINST WOUND INFECTION

Factors In Wound Infections



Bacteria

Usually endogenous (95%)

- *gut*
- *skin flora*

Prevention - prophylatic antibiotics

adequate pre-operative skin preparation

asepsis techniques

minimise wound exposure (operation time)

operating theatre discipline

Wound

4 types - *clean (2-5% risk)*

clean contaminated (5-15% risk)

contaminated (20-30% risk)

dirty (> 40 % risk)

Prevention - good surgical techniques

careful tissue handling

proper haemostasis

avoid foreign bodies implantation

avoid tissue ischaemia

wound cleansing before closure

wound dressing

Host

Concurrent medical illness - metabolic diseases

immunocompromise states

Malnutrition

Prevention - correct/optimise medical conditions

optimise host resistance

POST-OPERATIVE MANAGEMENT

2.1 Postoperative Pain Relief
2.2 Wound Dehiscence
2.3 Postoperative Respiratory Complications
2.4 Postoperative Confusional State
2.5 Fever In The Postoperative Period
2.6 Deep Vein Thrombosis
2.7 Acute Pulmonary Embolism

2.1 POSTOPERATIVE PAIN RELIEF

Adverse Effects Of Postoperative Pain

1. Decreased respiratory movements especially after upper abdominal surgery or thoracotomy, leading to shallow breathing, atelectasis and mucus retention.
2. Decreased mobility increasing the risk of deep vein thrombosis.
3. Increased sympathetic discharge leading to haemodynamic changes causing decreased tissue blood perfusion.
4. Worsen hormonal and metabolic activities after surgery to increase protein breakdown and mobilisation of fatty acids.
5. Depressed immune function and bacterial clearance.

Methods Of Pain Relief

1. Anaesthetic Blocks

* intercostal block
* epidural block (marcaine)
* field block (local infiltration)
* local wound infiltration

* *epidural block can be administered postoperatively by repeated boluses or continuous infusion via a catheter placed in the epidural space. The dangers of total spinal block should be anticipated and continous monitoring by pulse oximetry available*

* *intercostal block can be administered by single injection or by intermittent boluses/continuous infusion via a catheter in the intrapleural space*

2. Nerve Interruption

Cryoprobe ablation of intercoastal nerves after thoracotomy

Transcutaneous electrical nerve stimulation

3. Systemic Analgesia

Opiates - see below

NSAIDs - not useful during the immediate postoperative period but can supplement the opiates

useful for prolonged usage when opiate addiction can be a problem

suppository preparation allows for non-oral route of administration and avoidance of injection(Voltaren)

can cause gastritis and bleeding

Parcetamol - less gastric and coagulation problems

Ketamine - useful in children when changing dressing

Entonox - useful for dressing deep cavity

Factors Affecting Analgesic Requirement :

* site (thorax, upper abdomen worse than lower abdomen)

* age

* pyschological factors - personality

culture

social background

motivation

previous experience

* pre-operative psychological preparation

TYPES OF OPIATES ADMINISTRATION

1. Intramuscular intermittent bolus dosing (on demand or scheduled)

2. Intravenous route - intermittent or continuous infusion

   - patient controlled analgesia (see below)

3. Intra-thecal - respiratory depression may occur. Close monitoring with pulse oximetry recommended.

4. Sublingual - Buprenorphine (Temgesic ®)

5. Oral - Tramadol (Tramal ®)

   methadone, morphine : (usually for chronic pain)

6. Transdermal - fentanyl patch

Patient Controlled Analgesia

This method allows for patient to determine their own rate of administration. There are safety features in the machine to prevent overdosing. The limit can be set by preset doses, number of doses or lockout period. The machine can be designed to function in two modes.

1. Background infusion with preset limit for patient controlled intermittent bolusing

2. Preset timed bolus dosing by patient

NOTES ON OPIATE RECEPTORS

5 types identified : u, k, δ , σ, ε

Effects

u	supraspinal analgesia
	respiratory depression
	euphoria
	physical dependence
k	spinal analgesia
	miosis
	sedation
σ	dysphoria
	hallucinations
	respiratory depression
	vasomotor depression
δ	? involved in alterations of affective behaviour
ε	not fully understood

The route of administration can be either intravenous or intrathecal.

Opiates Affinity

	u	k	σ
Morphine	Ag	Ag	-
Pentazocine (Talwin)	Ant	Ag	Ag
Buprenorphine (Temgesic)	pAg		

Ag = agonist

Ant = antagonist

* *Ideally want k effects because they give analgesic effects but little euphoria (hence addiction) or dysphoria*

NOTES ON OPIATES

Endogenous

β *-endorphins*

Enkephaline - met-enkephaline

leu-enkephaline

Dynorphines

* endorphines are found mainly in the pituitary gland

* enkephalins are distributed both in the central nervous system and other extra-CNS sites : limbic system, thalamus, substantia gelatinosa as well as gastrointestinal tract and adrenal medulla

* dynorphins are only recently discovered and has been found in the gut, hypothalamus, posterior pituitary and brainstem

* acupuncture probably acts via release of these endogenous opiates because their effects are reversed by naloxone and enhanced by D-phenylalanine, an enkephalinase inhibitor

Exogenous

Natural alkaloids of opium

- *morphine*
- *codeine*
- *papaverine*

Semi-synthetic derivatives

- *dimorphine (heroin)*
- *oxymorphone*

Synthetic

- *pethidine*
- *fentanyl*
- *pentazocine*
- *methadone*

* these narcotics are used in 3 clinical settings - pain relief, anaesthesia and treatment of addiction (eg. methadone for drug addicts)
* problem of addiction is serious with the pure agonist but less with the agonist-antagonist
* however analgesia is potent with the agonist but has a ceiling effect with the agonist-antagonist
* drug combination of an agonist with an agonist-antagonist

* they act as neurotransmitters, occupying the opioid receptors

  (eg. pethidine with temgesic) is not addictive; instead the antagonist effect will reduce the efficacy of the pure agonist

* reversal of their effects can be obtained by the administration of the pure antagonist naloxone

2.2 WOUND DEHISCENCE

Two Types

A. Concealed - incisional hernia

B. Open - burst abdomen

superficial wound dehiscence

Factors Affecting Wound Dehiscence

1. Local Wound Environment

   * infection

   * local ischaemia

2. Suture Material

   * material fatigue

   * poor handling

3. Systemtic Factors Affecting Wound Healing

   * extremes of age

   * nutritional status

   * concurrent medical diseases eg.diabetes mellitus

4. Increased Tension at Closure Site

   * tight closure

   * increased intra-abdominal pressure

Prevention

1. Mass Closure Technique
2. Use strong, non-absorbable sutures for mass closure
3. Wound Infection Prophylaxis (see 1.8)
4. Good Closure Techniques
    * 4:1 suture length to incision length
    * 1 cm apart and 1 cm from wound edges
    * not strangulating
    * catch fascia (rectal sheath)
    * delayed closure when wound infection expected
5. Prevent Increased Intra-abdominal Pressure
    * nasogastric suction if ileus is anticipated
    * prevent coughing, constipation
    * abdominal corset
6. Tension sutures in cases of inadvertent increase in intra- abdominal pressure postoperatively

MANAGEMENT OF WOUND DEHISCENCE

Superficial Dehiscence

* release skin sutures and drain pus/haematoma
* healing by secondary intention or secondary suture when infection cleared and healthy granulation tissue covers wound

Burst Abdomen

* prevent dessication of exposed gut; cover gut with wet gauges

* abdominal wall closed as soon as possible with strong non absorbable sutures

* apply tension sutures

Concealed Dehiscence

* allow skin healing and treat the incisional hernia later

* if the neck of incisional hernia is wide, conservative management is acceptable especially in poor risk patients; however surgery is mandatory in those with narrow necks

* incisional hernia repair can be performed either

    intraperitoneal - anatomic (layer) repair

    extraperitoneal - keel repair, mesh

* mesh repair preferred in large hernia

* in large hernia, diaphragmatic splinting may result from the increase in intra-abdominal pressure caused by the returned bowel, precipitating respiratory embarrassment; the following preoperative manoeuvers may be required

    pneumoperitoneum to distend peritoneal cavity

    abdominal corset to reduce hernia

postoperatively,

    ventilatory support may be required

2.3 POSTOPERATIVE RESPIRATORY COMPLICATIONS

PREDISPOSING FACTORS :

Patient Factors

1. Obesity - decreased Function Residual Capacity

2. Elderly - higher incidence of aspiration

   poor respiratory efforts

   immobility

3. Smokers - chronic bronchitis

   poor oxygen carriage from higher levels of carboxyhaemoglobin (CoHb)

Lung Factors

1. Chronic Obstructive Lung Disease

   * airway obstruction from increased secretions

   * poor ciliary activity

2. Restrictive Airway Disease

   * decrease vital capacity

3. Cystic Fibrosis

   * viscid bronchial secretions

Surgical Factors

1. Damage to recurrent laryngeal nerve
    * aspiration
    * ineffective cough
    * upper airway obstruction
2. Deep Vein Thrombosis
    * pulmonary embolism
3. Adult Respiratory Distress Syndrome
4. Surgical sites
    * higher incidence in thoracotomy and upper abdominal surgery because of pain and shallow breathing

TYPES

Raised Diaphragm With Decreased Functional Residual Capacity

CAUSES

1. *pain*
2. *Gastrointestinal distension*
3. *increase intra-abdominal pressure eg. repair of large hernia, ascites, paralytic ileus*
4. *morbid obesity*

Pulmonary Collapse And Consolidation

CAUSES

1. *impaired ventilation of lung bases*
2. *bronchial secretions*
3. *assoc superimposed infections*
4. *smokers, COLD, obese, elderly*

Prophylaxis - incentive spirometry

doxapram

Treatment

1. vigorous chest physiotherapy
2. antibiotics
3. nasally introduced endobronchial toilet
4. fibreoptic bronchoscopic suction
5. minitracheostomy for bronchial toilet

Aspiration

CAUSES

1. *prophylactic nasogastric suction*
2. *intubation and extubation during general anaesthesia*
3. *paralytic ileus, gastric dilatation*

Treatment
1. vigorous chest physiotherapy
2. vigorous bronchial toilet
3. bronchodilators
4. methylprednisolone
5. antibiotics
6. assisted ventilation

Pneumothorax

CAUSES

1. *central venous line insertion*
2. *positive pressure ventilation with subsequent rupture of pre-existing bullae*

Prophylaxis
- proper subclavian vein insertion
- pressure controlled ventilation

Treatment
- chest tube

Pleural Effusion

CAUSES

secondary pulmonary pathology

congestive cardiac failure

leak after oesophageal resection

subphrenic abscess

Treatment 1. aspiration

2. chest tube drainage

3. treat underlying cause

Pulmonary Embolism - see deep vein thrombosis and pulmonary embolism

POSTOPERATIVE HYPOXEMIA

- can occur up to one week postoperatively

- 2 phases : early (within 24 hours)

late (that occuring after 24 hours)

Patients At Risk

1. Those with some pre-existing respiratory embarrassment

Chronic obstructive lung diseases (COLD)

Obesity

Smokers

Elderly

2. Those with pre-morbid states that are sensitive to hypoxaemia

Ischaemic heart disease

Cerebrovascular accident

Anaemias

Head Injury

3. Operation Sites

   Thoracic

   Abdominal (upper worse than lower)

   Major orthopaedic procedures

Causes

1. Immediate postoperative period (recovery)

   - assisted ventilation during anaesthesia caused V/Q imbalance (see section on Ventilatory Support 3.3) which continued into the recovery period

   - residual effects of the anaesthetic gases result in hypoventilation

2. In the ward

   - shallow rapid breathing cause tidal volume to encroach upon closing volume so that small airways close; this may result from pain. Analgesia can only partially offset the functional residual capacity changes which can be decreased by as much as 40%

   - postoperative opioids can depress the respiratory centres so that hypoventilation occurs

   - ? changes in sleep patterns : it has been noted that REM sleep is suppressed during the first few postoperative day (maybe contributed by opioid administration), and on the third and fourth night there may be a REM sleep rebound. This REM sleep rebound causes relaxation of the rib cage and the upper airway muscles so that obstructive apnoea occurs; this may explain why post-operative strokes, mycocardial infarct and unexplained delirum commonly occurs during this period.

2.4 POSTOPERATIVE CONFUSIONAL STATES

Never dismiss this complaint from the nursing staff till organic causes are excluded. Psychiatric disorders are diagnoses of exclusion and sedatives should be prescribed with care

Causes

1. HYPOXIA

* Postoperative pulmonary complications
* Disconnected/blocked ventilator tubing
* Fat embolism after orthopaedic surgery

2. ELECTROLYTE IMBALANCES

* Inadequate replacement
* Inappropriate infusion fluid eg. D5%
* Water absorption after TURP

(important in renal impaired patients)

3. HAEMODYNAMIC INSTABILITY

* Acute Myocardial Infarction
* Pulmonary embolism

* Haemorrhagic/septicaemic shock

* Cardiac arrhythmias

4. METABOLIC

* Thyrotoxic crisis

* Hepatic encephalopathy

* Diabetic metabolic complications

* Steroid withdrawal

5. DRUGS

* Sedatives

* Hypnotics

* Narcotics

6. CEREBROVASCULAR ACCIDENT

* Especially after carotid endarterectomy, cardiac surgery

* Significant intraoperative hypotension

* Risk groups include elderly, previous strokes, hypertension, ischaemic heart disease

7. URINARY RETENTION

* Blocked catheters

* Pain

* Unmasking of subclinical BPH with bladder distension that occurs intraoperatively

* Pelvic nerve neuropraxia after pelvic surgery

8. PSYCHIATRIC DISORDERS

* Failure to continue medication for those with psychotic disease postoperatively

* Acute delirium

* Alcohol withdrawal

* Senile dementia

* ICU syndrome

* Postcardiotomy delirium

* Anxiety and depressions

2.5 FEVER IN THE POST-OPERATIVE PERIOD

1st POST-OPERATIVE DAY

1. Pulmonary causes - atelectasis

   retained secretions

   * *more common after prolonged mechanical ventilation.*
   * *pre-existing chronic obstructive lung disease*
   * *poor cough efforts from pain or poor motivation*
   * *over sedation*
   * *abdominal distension*

2. Reactive fever
3. Pre-existing febrile illness
4. Manipulation of septic focus
5. Metabolic causes - thyrotoxic crisis

   diabetic ketoacidosis

3rd - 5th POST-OPERATIVE DAYS

1. Infections - urinary tract infection

   chest infection

   thrombophlebitis

   wound infection

   intra-abdominal abscess eg. pelvic, subphrenic

2. Deep vein thrombosis

3. Pulmonary embolism

6th - 10th POST-OPERATIVE DAYS

1. Gastrointestinal anastomotic leakages

2. Duodenal stump blow-out

VARIBLE ONSET

1. Suppurative parotiditis

   - especially in the elderly and those with poor oral hygiene

2. Acalculous cholecystitis

3. Post-operative pancreatitis

4. Drug allergy

5. Aspiration pneumonia

1/3-5/6-10

2.6 DEEP VEIN THROMBOSIS

1/3 of postoperative patients develop DVT; of these half are occult.

20% of patients with postoperative DVT are clinically significant.

10% of patients with postoperative DVT develop pulmonary embolism.

25% of surgical patients developed DVT after discharge.

Virchow's Triad

1. Intimal damage

2. Stasis

3. Hypercoagulable blood

Risk Factors

Disseminated Malignancy

Multiple Trauma

Previous deep vein thrombosis

Elderly patients undergoing hip surgery, open prostatectomy, pelvic surgery.

Non-ambulant patients especially with :

* acute myocardial infarction

* cerebrovascular accident

Hypercoagulable states :

* postoperative states

* post-splenectomy thrombocytosis

* polycythemia

* congenital deficiency of antithrombin III

Others - obesity

age

pregnancy

drugs eg. stilboesterol, oral contraceptive pills

smoking

dehydration

Natural History

1. Majority resolved with re-canalisation but has increased risk of DVT during subsequent pregnancy and surgery.
2. Problem of damaged valves and resulting varicose veins and venous ulcers(post-phlebitic syndrome)
3. Risk of pulmonary embolism, usually from ilio-femoral thrombus.
4. Danger of phlegmasia - alba dolens

caerula dolens

Diagnosis

A. CLINICAL - woody hard limb

swollen, warm

Homan's sign

B. NON-INVASIVE INVESTIGATIONS

- doppler ultrasound

impedance
phlethysmography

I^{131} fibrinogen scan

duplex ultrasound

* positive doppler ultrasound = absent venous hum or no change of venous hum with respiration and calf compression. Picks up pelvic phlebothrombosis better.

* I^{131} fibrinogen test is cumbersome with false positive in the presence of recent wound/inflammation. Not useful in pelvic phlebothrombosis because of greater background uptake.

* duplex ultrasound is now replacing venogram as primary investigation.

C. INVASIVE INVESTIGATION

- venogram.

* gold standard but is slowly being replaced by duplex ultrasound.

* risk of dislodgement of thrombus.

* 2 methods : direct venopuncture

intra osseous puncture

* 2 types : ascending venogram

descending venogram (assess patency of valves)

MANAGEMENT

PREVENTION :

1. Identify risk groups and institute prohylactic measures.
2. Physical methods - early postoperative ambulation

   graduated elastic stocking

   electrical calf stimulation

   external pneumatic compression

- **Graduated elastic stocking can reduce the incidence of postoperative deep vein thrombosis by 50%; it is used alone for low risk groups. When used in combination with low-dose heparin, the incidence of thrombosis is further reduced by 50% compared to if heparin is used alone.**
- **External pneumatic compression is as effective as low-dose heparin. It is reserved for moderate risk patients in whom there may be contraindications to heparin, or in very high risk patients when all modalities of prevention are required.**

3. Chemical Methods

   A. *Heparin :*

   * s/c 5000u 2 hours pre-op and then 8 hourly till mobilisation complete.
   * I/V heparin to achieve 1u/ml blood during surgery, then 2u/ml blood postoperatively.
   * low-molecular weight heparin.

- **low-molecular weight heparin is more effective than heparin without any increase in haemorrhagic complications**

   B. *Dextran :*

   500 mls intra-operatively, followed by 500 mls daily for 5 days.

   C. *Oral Anticoagulation :*

   to achieve PT 2x normal

D. *Anti-platelet Agents :*

not of proven effectiveness

4. Others - stop smoking

stop oral contraceptives

careful intra-op positioning especially stirrups

Prophylaxis is the cornerstone of management of deep vein thrombosis.

Anticoagulation is contra-indicated in neurosurgical procedures, peptic ulcer disease and in TURP. In such cases, physical methods are employed.

I/V heparin and oral anticoagulants are used only for high risk patients.

Prophylaxis may need to be continued as long as 6 weeks after surgery.

TREATMENT

1. Thrombus less than 5 cm and confined to calf where risk of embolism is minimal.

   * Graduated compression stocking and simple analgesia.

2. More than 5 cm or with proximal extension.

   * I/V heparin 10000u loading dose, then 5000u 6 hourly; either intermittent dosing or continuous infusion. To achieve clotting time > 5 mins.

   * add oral warfarin 2 days later and continue for 3 months; achieve PT 2X normal.

   * overlap of 5 days in which both heparin and warfarin given.

3. Iliofemoral thrombosis

   Above with addition of :

   - bed rest
   - avoid constipation
   - graduated compression stocking
   - continue warfarin for 6 months

4. Severe DVT with impending venous gangrene

   * thrombectomy with fogarty catheter
   * create A-V fistula between saphenous vein and superficial femoral artery to prevent re-thrombosis

5. Repeated pulmonary embolism and where proximal thrombus shown to be free floating on venogram.

   * partial or total venous interruption using caval umbrellas/ filters in the superior vena caval or iliac veins.

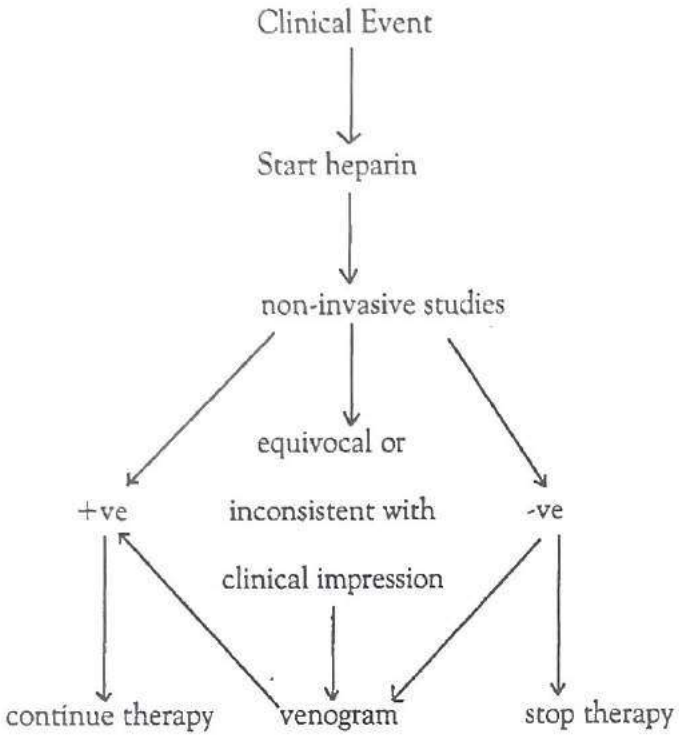
6. Phlegmesia cerulae dolens

   (Problem of total venous occlusion with high incidence of venous gangrene and amputation rate)

   - fibrinolytic therapy using streptokinase or urokinase

     * *danger of loosening thrombus and subsequent embolism*
     * *may cause troublesome bleeding from lysis of clots in recent wound or where extensive raw area present, hence unwise to use it within 3 days of an operation.*
     * *heparin treatment as outlined above should be instituted at the same time.*

SUMMARY



* better to err on the side of early treatment before conclusive investigation done.

RECOMMENDED READING

Nicolaides AN, Kalodiki E (1992) : *Deep Vein Thrombosis*: Aetiology, Prevention and Management. Aust NZ J Surg, 62 : 599 - 600

2.7 ACUTE PULMONARY EMBOLISM

Leading cause of mortality and morbidity in the west, but infrequent in Asians.

Less than 10% result in death.

Many are asymptomatic (60% found in routine autopsies, of which only 10-30% have antemortem diagnosis).

Source of clot in the leg veins especially those in the thighs.

Clincial Features

1. History and physical examination can be deceptively normal.
2. High index of suspicion needed.
3. Laboratory confirmation required.

Symptoms

Diagnosis should be considered when

1. sudden onset of unexplained dyspnoea
2. pleuritic chest pain and haemoptysis (occur when infarction present; happens in only 10% of cases)

Diagnosis should be suspected when

1. unexplained cardiac arrhythmias
2. sudden or progressive worsening of cardiac failure

3. sudden deterioration in patients with obstructive lung disease
4. unexplained arterial hypoxaemia
5. possible alternative to the diagnosis of "pyschic" hyper ventilation

Signs

1. Cardiovascular System
   - tachycardia
   - heart : right ventricular gallop
     palpable precordial "lift"
     loud pulmonary closure sound
     (wide, fixed splitting of S_2)
   - prominent "a waves" in jugular venous pulse
2. Lungs
   - systolic or continuous murmur accentuated by inspiration
   - pleuritic rub

Investigations

1. Electrocardiogram
   - normal in most cases
   - in extensive embolism, there is evidence of acute pulmonary hypertension (right axis deviation, tall P, ST-T changes indicative of right ventricular strain)
   - $S_1 Q_3 T_3$ pattern

2. Chest Radiograph

- normal findings does not exclude diagnosis
- abrupt "cut off" of a vessel
- abnormal lucency in some lung fields
- infarcts, pleural effusion and parenchymal infiltrate may be seen

3. Blood Gases

- hypoxaemia, hypocapnia with respiratory alkalosis
- normal pO_2 does not exclude diagnosis

4. Definitive Investigations

- pulmonary perfusion and ventilation scan
- pulmonary angiograms

CLASSIFICATION

Group 1

1. no signs or symptoms
2. pulmonary arterial occlusion <20%

- *no treatment needed*

Group 2

1. tachypnoea

2. 20 - 30% pulmonary arterial occlusion

3. mean pulmonary arterial wedge pressure (PAWP) <20 mmHg

- *anticoagulation only*

Group 3

1. hypoxia and collapse

2. 30 - 50% pulmonary arterial occlusion

3. mean PAWP > 20 mmHg

- *anticoagulation and caval filter*

Group 4

1. circulatory collapse

2. > 50% pulmonary arterial occlusion

3. mean PAWP > 30 mm Hg

- *embolectomy with suction catheter and caval filter; if patient had arrested, open embolectomy*

Group 5

1. cor pulmonale

2.> 50% pulmonary arterial occlusion

3. mean PAWP > 40 mmHg

- *anticoagulation and caval filter*

- Greenfield and Langham (1984)

TREATMENT

When To Start

1. strong clinical suspicion and supportive routine laboratory tests

2. immediately unless heparin therapy places patient at a clear risk

Aim Of Treatment

1. immediate inhibition of thrombus growth

2. promotion of thrombus resolution

3. prevention of embolic recurrence

Types Of Therapy

* heparin

* thrombolytic agents

* surgery

Regimes

A. *Heparin* :

1. Initial - IV 15,000 - 20,000 u bolus

2. Then 1 of 2 regimes

    a. continuous IV infusion 1,000 u/hr

    b. intermittent IV 5,000 - 7,500 u 94 H

    if IV therapy not suitable

a. 7,500 u subcutaneous 96H

or b. 10,000 u subcutaneous 98 H

(Intramuscular administration should be avoided because of haematoma formation)

3. Monitoring - bleeding time should be 2X normal

4. Other supportive measures - maintain pO_2 > 50 mmHg

B. *Thrombolytic :*

Streptokinase

Urokinase

* given as systemic dosing or contact dissolution via arterial catheter

* problem of bleeding especially in early post- operative period

C. *Surgery :*

1. Pulmonary Embolectomy

   - major, complex operation with 50% operative mortality

   - 50% operative mortality

2. Venous Interruption (inferior vena caval or iliac vein)

   - ligation or plication

   - filters

3 ANAESTHESIA

3.1 Principles of Anaesthesia
3.2 General Anaesthesia
3.3 Regional Anaesthesia
3.4 Local Anaesthesia
3.5 Hypothermia in Surgery

3.1 PRINCIPLES OF ANAESTHESIA

Basic Concerns

1. Safety of Patient for Surgery

   * airway protection

   * adequate ventilation

   * haemodynamic stability (volume, oxygen carriage)

2. Comfort of Patient (NARCOSIS AND ANALGESIA)

   * sedation/unconsciousness

   * amnesia of surgical trauma

   * pain relief

3. Ease of Surgery

   * co-operative patient

   * muscle relaxation

   * controlled hypotension to reduce bleeding

Pre-Anaesthesia Assessment

1. Ensure patient is at optimal fitness for anaesthesia

   - medical history and treatment

   - screening investigations

2. Psychological preparation

- establish rapport with patient to allay anxieties
- explain choice of anaesthesia and anaesthetic procedure

3. Pre-Medication

- sedation
- antiemetics
- antacids/H_2 antagonist
- analgesics
- antisialogogue

4. Classification of fitness for surgery (American Society of Anaesthesiologist (ASA) Classification)

I. Patient has no organic, physiological, biochemical or psychiatric disturbance. One pathological process for which operation is to be performed is localised and does not entail a systemic disturbance.

II. Mild or moderate systemic disturbance caused either by the condition to be treated surgically or by other pathophysiological processes. Mild organic heart disease, diabetes, mild hypertension, anaemia, old age, obesity, mild chronic bronchitis.

III. Limitation of Lifestyle. Severe systemic disturbance or disease from whatever cause, even though it may not be possible to define the degree of disabilities with any finality eg. angina, healed myocardial infarction, severe diabetes, cardiac failure.

IV. Severe systemic disorders that are already life threatening, not

always correctable by operation eg. marked cardiac insufficiency, persistent angina, active myocarditis, advanced pulmonary, renal, endocrine or hepatic insufficiency.

V. Moribund. Little chance of survival, but submitted to operation in desperation. Little if any anaesthesia is required. If the operation is an emergency, the letter E is placed beside the numerical classification, and the patient is considered to be in poorer physical condition.

Techniques of Anaesthesia

GENERAL ANAESTHESIA

* with muscle relaxation

* without muscle relaxation (inhalational)

REGIONAL ANAESTHESIA

* central neural blockage eg. epidural, spinal

* peripheral plexus block eg. brachial block

* peripheral nerve block eg. intercostal block

* intravenous regional analgesia eg. Bier block

* field block eg. for inguinal herniorrhaphy

LOCAL ANAESTHESIA

* surface anaesthesia eg. topical cream, gel, spray

* local infiltration

OTHERS

* neuroleptanaesthesia

* dissociative anaesthesia - ketamine

Intra-Operative Monitoring

1. BASIC (for all cases)

* Haemodynamic : blood pressure and pulse rate every 5-10 mins

Two types of blood pressure

indirect : sphygmomanometer

direct : intra-arterial line

Indications for direct BP measurement

* *major cardiothoracic, vascular surgery*
* *deliberate hypotension*
* *unstable cardiovascular state*
* *anticipated large changes in blood pressure*
* *major surgery where large blood loss and fluid shift anticipated*
* *frequent blood sampling anticipated*

* Cardiac : continuous ECG

* Ventilation : end-tidal CO_2

* Oxygenation : pulse oximetry

* Inspired oxygen concentration : oxygen analyser

2. OTHERS

* temperature

* hourly urine output for long and major cases

SUGGESTED READING

AR Aitkenhead and G Smith (eds) (1990) *Textbook of Anaesthesia*, 2nd ed. Churchill Livingstone, London.

3.2 GENERAL ANAESTHESIA

THREE PHASES :

Induction

Maintenance

Reversal

Induction

- intravenous or inhalational

INTRAVENOUS

* thiopentone
* methohexitone
* ketamine
* propofol
* etomidate
* midazolam/valium
* fentanyl/morphine

INHALATIONAL

* halothane
* enflurane
* isoflurane
* cyclopropane

* Intravenous induction is generally preferred because it is smooth, fast and least disturbing

* Inhalational induction is preferrable for children and those with potential airway problems

Maintenance

- *with or without muscle relaxation*

1. "Balanced" technique :

narcosis, analgesia and muscle relaxation

* nitrous oxide

* inhalational agent

* narcotics for pain relief

* muscle relaxants

* *two types of muscle relaxants : non-depolarising and depolarising. Non-depolarising agents act by competitive inhibition while depolarising agents interact with the receptors resulting in cell-membrane depolarisation and prevents further activation of the receptors*

* *Non-deplorarising agents : d-tubocurare (effects last 45 mins), pancuronium (20-30 mins), gallamine and alcuronium (20 mins), atracurium and vecuronium (10-20 mins). Reversed by anti-cholinesterase. Relaxed muscle is still responsive to mechanical and electrical stimuli*

* *Depolarising agents : suxamethonium (short-acting). Causes muscular fasciculation. The depolarised muscles are not responsive to other stimuli and cannot be reversed by anti-cholinesterases. Antagonised by non-depolarising relaxants. Side-effects include prolonged apnoea (in patients with atypical or low serum cholinesterase), hyperkalemia, muscle pains and malignant hyperpyrexia*

* *in general, depolarisers should not be used after non-depolarisers; only if the effects of the first drug have worn off should one of the other group be used.*

2. Total intravenous technique eg. propofol infusion

Reversal

1. Anticholinesterase (neostigmine, edrophonium) to reverse muscle relaxants; newer muscle relaxants eg. atracurium, vecuronium may not require reversal.

2. Atropine to obtund anti-muscarinic effects of anticholinesterase.

EXTUBATION ONLY WHEN ADEQUATE SPONTANEOUS RESPIRATION NOTED

PATIENT MAY BE KEPT INTUBATED IN :

- **a. major cardiothoracic surgery**
- **b. neurosurgical patients**
- **c. premature babies requiring intensive postoperative care**
- **f. distended abdomen**
- **g. potential respiratory embarassment**

*** signs of incomplete reversal include shallow breathing, jerky respiration, cyanosis, restless and struggling patient, diplopia, inability to raise head or extrude tongue, tracheal tug and see-saw respiration (where the abdomen moves out and the chest moves in)**

SPECIAL TECHNIQUES

A. Induced Hypothermia - see later section on HYPOTHERMIA IN SURGERY

B. Deliberate Hypotension

* to reduce blood loss

* applicable in mastectomy, spine surgery, TURP

* require close direct blood pressure monitoring; keep systolic BP at

80 - 90 mmHg

* urine output monitoring

COMPLICATIONS

1. Complications of intubation and mechanical ventilation
   * aspiration
   * failed intubation
   * barotrauma
2. Agent toxicity
   * allergy
   * malignant hyperpyrexia
   * hypotension
   * respiratory depression
   * myocardial depression
   * halothane hepatitis
3. Equipment failure
   * disconnection
   * blocked tubes
   * ventilator failure
   * flow meter delivering wrong concentration of oxygen

SUGGESTED READING

General Anaesthesia. In : Atkinson RS, Rushman GB, Lee Ja (eds) (1987). ***A Synopsis of Anaesthesia.*** **PG Publishing Pte Ltd, Singapore.**

3.3 REGIONAL ANAESTHESIA

Types

- see section on PRINCIPLES OF ANAESTHESIA

Advantages

1. Effects of drug limited to the operative field
2. After-effects usually less than after general anaesthesia especially in long operation such as tendon transfers
3. Postoperative pain relief eg. continuation of epidural block post-operatively via epidural catheter
4. Early detection of complications eg. bladder perforation during TURP

Relative Contraindications

* Uncooperative patients eg. young children, psychotics, stuporose patients
* Allergy to anaesthetic agent
* Septic focus near site of puncture
* Early detection of complications important eg. compartmental syndrome after limb surgery
* Presence of coagulopathy

Complications

1. depends on site of administration

SPINAL - *spinal headache*

meningitis

backache

hypotension

total spinal block with cardiorespiratory arrest

spinal cord injury

BRACHIAL PLEXUS BLOCK -

pneumo/chylothorax

phrenic nerve injury

venous injection

arterial injection

NERVE BLOCK-*nerve injury*

BIER BLOCK - *high systemic levels of lignocaine from rapid termination*

2. agent toxicity (see section on local anaesthesia)

3. systemic absorption of adrenaline (when used) in hypertensive, hyperthyroidism, beta-blocked or arrhythmi-prone patients can cause fatality

4. gangrene when vasoconstriction agents used in nerve blocks of penis, toe or finger

SUGGESTED READING

JAW Wildsmith and EN Armitage (eds) (1987) *Principles and Practice of Regional Anaesthesia.* Churchill Livingstone, London

3.4 LOCAL ANAESTHESIA

Types

- see section on PRINCIPLES OF ANAESTHESIA

Agents

* lignocaine
* bupivacaine
* EMLA (prilocaine + lignocaine)

Pharmacology of Local Anaesthetics Agents

1. drugs are water soluble salt of lipid soluble alkaloids
2. either esters or amides
3. most local anaesthetic agents are weak bases available as hydrochlorides in modified Ringer solution
4. can become ionised in acid media and hence rendered ineffective eg. abscess
5. multidose local anesthetic agent contains preservatives which may cause neurotoxicity

Action of Local Anaesthetic Agents

* act by blocking sodium channels of surface membrane thus preventing propagation of nerve impulses
* in myelinated nerve, the site of action is at the node of Ranvier

Toxicity

Factors Which Influence Toxicity :

1. quantity of solution
2. concentration of drug
3. addition of adrenaline
4. vascularity of site of injection
5. rate of absorption and metabolism of drug
6. hypersensitivity of patient
7. age, physical status, weight of patient

Manifestations of Toxicity :

Central Nervous System

1. stimulation followed by depression
2. restlessness
3. hysterical behaviour
4. vertigo
5. tremor
6. convulsion
7. respiratory failure

Cardiovascular System

1. hypotension
2. bradycardia
3. arrhytmias
4. heart blocks

Recommendations :
* lignocaine - 3 mg/kg BW
* lignocaine with adrenaline - 7 mg/kg BW
* marcaine - 2-4 mg/kg Bw

SUGGESTED READINGS

Wood M : Local Anaesthetic Agents. In : Wood M, Wood AJJ (eds) (1990). *Drugs and Anaesthesia.* Williams and Wilkins, Baltimore.

Savarese 22, Covino BG : Basic and Clinical Pharmacology of Local Anaesthetic Drugs. In : Miller RD (ed) (1986). *Anaesthesia 2nd edition.* Churchill Livingstone, New York.

3.5 HYPOTHERMIA IN SURGERY

Induced Hypothermia

A method to lower the metabolism of the body as a whole, and to reduce the dangers of hypoxia and the cellular damage resulting from regional occlusion of the circulation to the brain, heart, liver, kidneys and legs.

Stages of Induced Hypothermia
(after Cooper and Ross)

MILD HYPOTHERMIA (31° - 35° C)

Reduces tissue oxygen requirements so that if circulation is accidentally interrupted, hypoxic damage of major organ is less likely to occur

MODERATE HYPOTHERMIA (28 °- 30°C)

Used to protect essential tissures during ischaemic arrest or when it is necessary to interrupt the extracorporeal circulation

DEEP (PROFOUND) HYPOTHERMIA (< 25°C)

Used where total circulatory arrest is necessary eg. operation in aorta and neonatal cardiac surgery

Effects of Hypothermia

1. Cardiovascular System

* 30° C causes dysrrhythmias
* 28° C - ventricular fibrillation occurs
* Heart rate,blood pressure and cardiac output fall progressively
* Vasoconstriction of cutaneous vessels

2. Respiratory

* Oxygen dissociation curve shift to left
* Less oxygen availability to tissues because of depressed cardiac output and vasoconstriction
* Respiratory rate falls and ceases at 26° C

3. Acid-Base Balance - acidosis from :

* Lactic acid due to impaired liver function and depressed haemodynamic
* Respiratory acidosis from depressed respiration
* Impaired renal function

4. Central Nervous System

* Cerebral cortex can tolerate acute hypoxia from complete circulatory arrest for

  5 - 10 mins at 28 °C

  50 mins at 15 °C

* Consciousness lost at 28°- 30° C

5. Metabolism

* ≈1° C fall causes reduced metabolism of 6 - 7%
* Utilisation of glucose depressed causing tendency for hyperglycemia

6. Blood

* Clotting mechanisms depressed
* Platelet count falls rapidly
* Sludging in capillaries at low temperature
* Increased blood viscosity

Patients of all ages can tolerate mild and moderate hypothermia, but profound whole body cooling is applicable only to infants; older people are at risk from cerebral damage and other complications.

Techniques of Induced Hypothermia (General)

1. General Anaesthesia

- General anaesthesia with muscular relaxation. Prevents shivering and excessive vasoconstriction
- For profound hypothermia, phenothiazines are usually administered to facilitate heat loss

2. Surface Cooling

- Cold water, icebags, air cooling
- Cold tubing with anti-freeze in blankets

3. Blood Stream Cooling

- Used preferentially in cardiac surgery
- Blood taken from circulation are cooled by means of a heat exchanger and returned

Techniques of Induced Hypothermia (Regional)

1. GIT - stomach : ice-cold saline lavage through wide-bore Ryles tube

   colon and rectum : per-rectal irrigation with cold fluids

2. CNS -brain : carotid artery perfusions of cold solutions

   spinal cord : subarachnoid injection of cold saline

   nerves : cryoprobe

3. Myocardium - surface cooling

   cold cardioplegia

4. Urogenital Tract - kidney : cooled intra or extravascularly

   bladder : intravesical hypothermic balloon

5. Limb - surface cooling with icebags, cold water

Clinical Application

1. Control Haemorrhage - eg. bleeding gastric ulcer

2. Organ Protection

   - during cardiac and cerebral surgery

   - renal surgery : pyelolithotomy, renal split, partial nephrectomy, renal transplant

3. Limb preservation in acute vascular disease and trauma

4. Pain Control

   subarachnoid injection of cold saline

- cryoprobe for post-operative pain relief

5. Cerebral Resuscitation

   - during head injury and cardiac arrest to reduce hypoxic brain damage

6. Treatment of Specific Lesions

   - cryotherapy for haemorrhoids, nasal cell cancer

   - liquid nitrogen ablation of warts

NOTES ON HYPOTHERMIA FOR RENAL SURGERY

1. At normal temperature, kidney can withstand ischaemia without permanent damage for only 15 mins

2 Cooling the kidney to 15°C or 20°C can provide upto 2-3 hours protection against ischaemia

3. Surface cooling can be achieved by :

   * packing with crushed ice

   * irrigating the outside and inside of the kidney and pelvicalyceal system with ice-cold water

   * cold water heat exchange coils on surface of the kidney

4. Need to ensure temperature inside of the kidney does not fall below 15 ° C

5. Alternative to hypothermia is the administration of inosine 30-60 mg/kg into a peripheral vein 10 mins before operation or into the renal artery just before the occlusion clamp is applied. Protects against effects of total ischaemia for 1 hour.

NOTES ON HYPOTHERMIA FOR CARDIAC SURGERY

1. Whole Body Hypothermia

   - suitable for minor intracardiac procedures

2. Extracorporeal circulation with cold cardioplegia.

   - In which 1 L of potassium containing solution at 4°C is injected into the ascending aorta to decrease the metabolic requirement of the heart, and the patient's blood is led through an oxygenator from the SVC and IVC and returns to the ascending aorta. This is the preferred method.

CRITICAL CARE AND RELATED TOPICS

4.1 Monitoring in the Critically Ill Patients
4.2 Ventilators
4.3 Ventilatory Support
4.4 Approach to Multiple Injuries
4.5 Hypotension in Surgery
4.6 Blood Transfusion
4.7 Adult Respiratory Distress Syndrome
4.8 Surgical Nutrition

4.1 MONITORING OF CRITICALLY ILL PATIENTS

Setting

In intensive care units with concentration of trained staff and equipment for close continuous monitoring.

Levels of Intensive Care Unit

LEVEL 1 :

* District Hospital environment
* High Dependency Unit for close observation and electrocardiogram monitoring
* short term ventilation (usually <24 hours)

LEVEL 2 :

* General Hospital environment
* Can manage prolonged ventilatory requirements
* Resident doctor present
* Easy access to support sevices eg radiology, physiotherapy

LEVEL 3 :

* Tertiary Referral Centre environment
* Manage by specialist intensivists trained in internal medicine and anaesthesia, and critical care nurses
* Specialist support available at short notices eg. renal physician, cardiologists, etc.

* Equipped with more complex life-support services (eg dialysis), invasive monitoring equipments and ivestigations (eg. CT scans, angiograms)

Common Investigations

1. Electrolytes, blood sugar
2. Arterial blood gas analysis
3. Full blood count including platelets
4. Chest XRays
5. Continous electrocardiogram monitoring
6. Coagulation profile
7. Microbiological investigations

MONITORING OF HAEMODYNAMIC FUNCTION

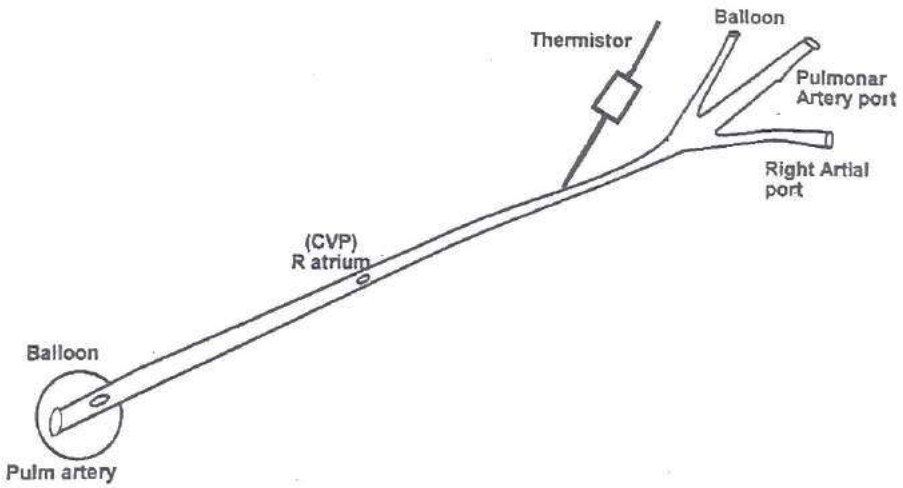
1. Pulse rate
2. Continuous ECG
3. Blood pressure (indirect or arterial line)
4. Hourly urine output
5 Fluid balance (intake/output chart)
6. Body temperature
7. Central venous pressure *
8. Pulmonary capillary wedge pressure *

9. Cardiac output *
10. Mixed venous oxygen saturation *
11. Oxygen Consumption *
12. Echocardiography
13. Radionuclide imaging

* Information can be obtained from a SWAN GANTZ catheter

SWAN GANTZ CATHETER

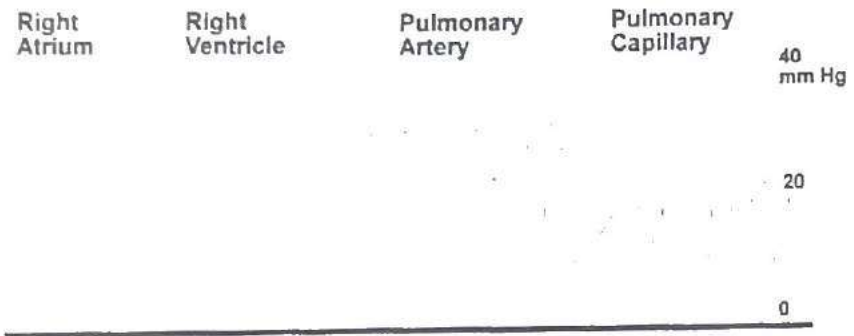
* balloon-tipped, flow-directed flexible floatation pulmonary artery catheter
* consist of 4 lumens -
  1. opening in right atrium
  2. balloon
  3. thermistor
  4. pulmonary artery mixed venous sampling through opening in pulmonary artery



Insertion : 1. Puncture of major vein eg. subclavian, internal jugular, cephalic, femoral

2. Blow up balloon and float catheter to pulmonary artery

3. Assessment of catheter placement - fluoroscopic or by observing the pressure profile



Typical wave form obtained upon passage of the Swan-Ganz catheter.

COMPLICATIONS OF SWAN-GANZ CATHETER INSERTION

Insertion	Passage of the Catheter	Catheter in situ
Lymphatic injury	Perforation	Bacteraemia
Carotid haematoma	Cardiac arrhythmias	Endocardial vegetations
Neurologic injury	Intracardiac knotting	Cardiac arrhythmias
Haemorrhage		Thrombocytopenia
Pneumothorax		Pulmonary artery perforation
		Pulmonary embolism
		Pulmonary infarction

Uses : 1. measuring right and left intra-cardiac pressures

2. measuring cardiac output

3. mixed venous blood sampling/oximetry

4. other minor uses - intra-cardiac ECG

cardiac pacing

1. Assessment of Intra-cardiac Pressures

* *measurement of pulmonary capillary wedge pressure (PCWP)*

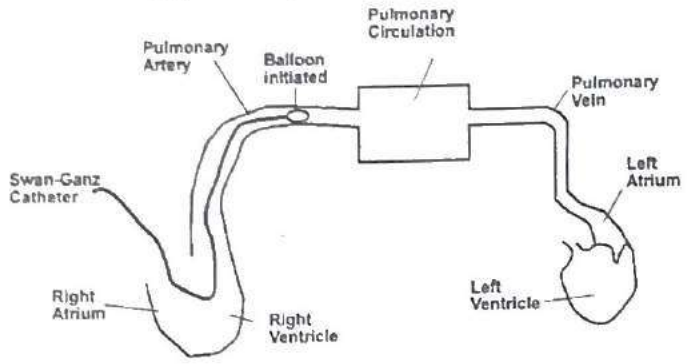


Diagram of the Heart Chambers, Pulmonary Circulation and Swan-Gantz Catheter in-situ

1. Inflate balloon and hence create a communicating channel from pulmonary capillary to aorta

2. In the absence of lesions affecting any of the chamber eg. mitral stenosis, PCWP is a reflection of the pressure in the various chambers

3. PCWP hence measures end-diastolic left ventricular pressure (EDLVP) which reflects left ventricular function

4. Conditions causing discrepancy between PCWP and LVEDP include

   * positive pressure ventilation

   * increased intrathoracic pressure

   * chronic obstructive lung disease

   * tachycardia

   * mitral valve stenosis/regurgitation

   * aortic regurgitation

   * pulmonary embolus

2. Measuring Cardiac Output

* *By thermodilution method*

1. Inject 10 mls of saline (0° C or room temperature) as fast as possible through CVP port.
2. Thermistor at tip of catheter will sense the drop in temperature.
3. By using the Stewart-Hamilton equation, cardiac output is calculated.
4. Balloon must not be inflated.

- **Can determine cardiac output at various PCWPs (preload) so that the range in which cardiac output is maximal may be known i.e. when the force exerted by the cardiac muscle on passive stretching is maximal (Starling's Law).**
- **Can assess effectiveness of inotropic drugs and the limit in which cardiac contractility can be improved.**
- **For titrating drugs affecting afterload such that cardiac output is maximised.**

3. Calculation of Vascular Resistance

* *Systemic Vascular Resistance (SVR)*

$$SVR = \frac{MAP - CVP}{CO} \times 80$$

(MAP = mean arterial pressure, CVP = central venous pressure, CO = cardiac output)

* *Pulmonary Vascular Resistance (PVR)*

$$PVR = \frac{PAP - PCWP}{CO} \times 80$$

(PAP = pulmonary arterial pressure, PCWP = pulmonary capillary wedge pressure)

4. Mixed Venous Blood Sampling/Oximetry

* *blood gas analysis of a true mixed venous blood.*

- large arterio-venous oxygen difference =

  a. low cardiac output

  b. high oxygen consumption state eg. sepsis

- small arterio-venous oxygen difference =

  a. high cardiac output

  b. peripheral shunting

  c. left to right heart shunt

  d. tissue respiratory poisoning by cyanide

* *continuous monitoring of mixed venous oxygen saturation (oximetry)*

- monitors cardiac function : if oximetry is falling, it indicates cardiac output is not providing adequate peripheral tissue oxygenation (HEART FAILURE). Can be due to failing heart, increased oxygen demand or decreased oxygen supply.

PULMONARY MONITORING

Ventilation

1. respiratory rate
2. tidal volume
3. minute volume
4. $PaCO_2$ and end-tidal CO_2 ($ETCO_2$)

Oxygenation

1. inspired oxygen conc (FiO_2)
2. PaO_2 : intermittent arterial sampling

   transcutaneous O_2 saturation by pulse oximeter
3. mixed venous sampling (see above)

Ventilatory Mechanics

1. Vital capacity
2. Forced Expiratory Volume (FEV)
3. Peak Expiratory Flow Rate (PEFR)
4. Airway pressure and airway resistance
5. Lung compliance
6. Ventilator settings (PEEP etc.)

Related parameters

1. chest x-rays
2. sputum culture
3. haemoglobin level and haematocrit
4. fluid balance

METABOLIC MONITORING

Fluid and Electrolye Balance

Acid-Base Balance - pH, base excess, serum bicarbonate

Blood glucose

Serum magnesium, calcium and phosphate levels

Liver function tests

Weight

Others - serum lactate level

serum anion gap

NEUROLOGICAL MONITORING

EEG

Somatosensory evoked potentials

Intracranial pressure monitoring

Glasgow Coma Scale charting

PROGNOSTIC SCORING SYSTEM IN INTENSIVE CARE

Purposes

1. Quality of Care measurement
2. Resource allocation - admission/exclusion criteria
3. Research - wide data-base collection

   more precision for clinical trials (by defining individual risk estimate improvement of predicted risk by various treatments can be more objective and precise)

APACHE III

3 components : APACHE III score

- Acute Physiology Score (APS)

- Chronological age

- Chronic Health Evaluation

Disease Classification

Selection Criteria (location before ICU)

* The scoring system works by relating the APACHE III score, diagnosis and selection criteria to a reference database of 17,440 patients' outcomes from 26 randomly selected hospitals and 14 non-randomised volunteer tertiary hospitals in the USA. From this database, extimates of hospital mortality, length of ICU stay, type and amount of therapy, and nursing intensity are obtained.

* APACHE III differs from APACHE II in that the score is not considered in isolation. This is because a first day score of 80 in a patient following abdominal surgery cannot be the same as one following drainage of intracranial haemorrhage. Similarly, a patient admitted directly from the A&E department cannot be rated the same way as a readmission to the ICU, or a patient after elective surgery, or emergency surgery.

Components of the APACHE III score

Physiological variables (APS) 0-252 points

- **Mean blood pressure**
- **Respiratory rate**
- **Temperature**
- **Pulse**
- **Glasgow coma score (modified)**
- **Urine output / 24 hours**
- **Haematocrit**
- **White blood count**
- **Blood pH**
- **Blood oxygen pressure**
- **Blood carbon dioxide pressure**
- **Serum sodium**

- Serum albumin
- Serum bilirubin
- Serum glucose
- Serum creatinine
- Blood urea nitrogen

Chronological age 0 - 24 points
Chronic health evaluation 0 - 23 points

- AIDS
- Hepatic failure
- Lymphoma
- Leukaemia / multiple myeloma
- Immunosuppression
- Metastatic cancer
- Cirrhosis

Other Scoring Systems

Sickness Scoring (Bion)

Simplified Acute Physiology Score (Le Gall)

Mortality Prediction Modules (Lemeshow)

Therapeutic Intervention Scoring System

RECOMMENDED READINGS

TE Oh (ed) (1990) *Intensive Care Manual*, 3rd ed. Butterworth, Australia

JE Zimmerman, WA Knaus and M Seneff (1993) *Outcome Predicition in Intensive Care.* In : *Intensive Care Rounds.* The Medicine Group (Education) Ltd, Abingdon.

4.2 VENTILATORS

Parts of a Functioning Unit

GAS SUPPLY

- 2 sources to provide air and oxygen

PNEUMATIC SYSTEM

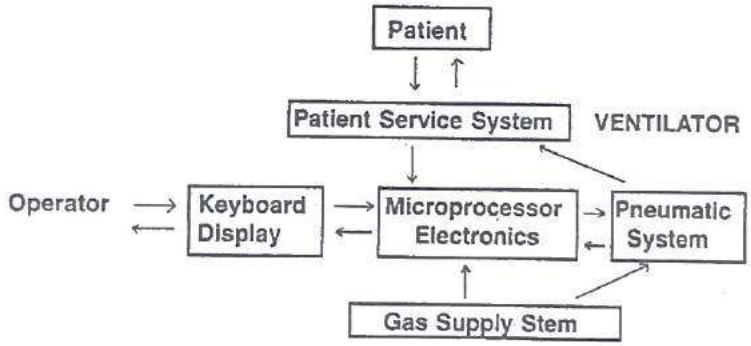
- to mix these gases and generate flow waveforms

MICROPROCESSOR ELECTRONICS

- control and monitor the pneumatic system

PATIENT SERVICE SYSTEM

- conveys the mixed gases to and from the patient include humidifier and a nebuliser



PHASES OF VENTILATOR OPERATONS

INSPIRATORY PHASE

Gas flow created by flow or pressure generators

INSPIRATORY TO EXPIRATORY PHASE

Cycling determined by :

time

volume of gas flow *OR*

pressure in system

EXPIRATORY PHASE

Normal chest wall compliance with gas flow cut-off

EXPIRATORY TO INSPIRATORY PHASE

Cycling determined by :

time *OR*

pressure in system

Servo 900C System

- volume or pressure preset, time-cycled ventilator
- can be use for paediatric and adult patients

PRIMARY VARIABLES SET : minute volume, respiratory rate, inspiratory time

OTHER CONTROLLABLE : sigh, trigger sensitivity, flow waveform, pause time

MODES AVAILABLE : control, assist / control

SIMV, SIMV with pressure support

PEEP / CPAP

Pressure support

Manual (via resrvoir bag)

MONITORS : FiO_2

tidal volume, expired minute volume

respiratory rate

airway pressure (peak, pause, mean)

THE OPTIMAL VENTILATORY PATTERN

- (Hillman, 1986)

1. Tidal Volume

In normal lungs, large tidal volumes (10-15 mls/kg) tend to minimise right to left ventricular shunts. In abnormal lungs, because of variation in regional compliance, over inflation of normal regions may result in increased dead space ventilation. In this situations, a combination of smaller tidal volume (5-10 mls/kg) and PEEP is recommended to recruit poorly ventilated and collapsed alveoli, improving the distribution of ventilation.

2. Inspiratory Flow Rate and Frequency

Rapid inspiratory flow rates increase dead space by preferentially ventilating lung units with short time constants. The respiratory rate may need to be increased to prevent hypoventilation when high tidal volumes or peak inspiratory pressures are undesirable. With severe airflow obstruction, a low respiratory rate is recommended to allow sufficient time for expiration, thus avoiding air trapping.

3. Inspiratory Flow Pattern

There appears to be no clear advantage over any particular pattern.

4. I/E Ratio

The ratio should be sufficient to allow adequate time for expiration and is generally less than 1:1 (1:2 to 1:4)

5. Positive End-Expiratory Pressure (PEEP)

PEEP is generally indicated to allow maintenance of adequate oxygenation with a lower FiO_2, thereby reducing the risk of oxygen toxicity. The usual range of PEEP employed is 5-15 cm H_2O and this is adjusted to maximise oxygenation without overdistension, barotrauma and cardiac output depression. The risk of PEEP is low when pulmonary compliance is high and patient normovolaemic.

6.Fractional Inspired Oxygen Concentration (FiO_2)

This should be less than 0.6 in adults.

7. Airway Pressure

Peak and mean airway pressures should be minimised as much as possible and in general should be less than 20 cmH_2O.

8. Mode of Ventilation

Controversy exists as to the best mode. The choice should be tailored to the condition of the patient.

4.3 VENTILATORY SUPPORT

MODES

Two Basic Types :

A. Controlled Ventilation

Full - Controlled Mechanical Ventilation

Partial Intermittent Mandatory Ventilation

(combination of assisted ventilation and controlled ventilation; with controlled ventilation as backup)

B. Assisted Ventilation

Triggered Ventilation

Pressure Supported (or Assist)

Newer variations

* high frequency ventilation

* inversed ratio ventilation

* differential lung ventilation

Pressure Support

PEEP - positive end-expiratory pressure

CPAP - continuous positive airway pressure

In pressure-controlled ventilation as opposed to volume-controlled ventilation, the volume of gas that is delivered to the patient is determined by the set

inspiratory time. This volume may vary depending on the compliance and airway pressure. Lately, the concept of pressure-regulated volume controlled ventilation is introduced whereby the inspiratory pressure is regulated to a value based on the volume/pressure calculated from the previous breath. This way there is a breath-by-breath control to maintain a preset target tidal/minute volume.

CONTROLLED VENTILATION

Mechanical ventilation by ventilator doing all the necessary work of breathing; positive pressure breaths are delivered at fixed time intervals. Can either be VOLUME-CONTROLLED (deliverance of a pre-determined volume of gas to the lungs irregardless of airway pressure; danger of barotrauma) or PRESSURE-CONTROLLED (applies a desired pressure to the airways; volume delivered may not be adequate if set pressure is reached quickly, but barotrauma is less likely)

A. Intermittent Positive Pressure Ventilation (IPPV)

- intermittent application of positive pressure to the airway; during expiratory phase, the airway pressure returns to zero

B. Continuous Positive Pressure Ventilation (CPPV)

- positive airway pressure throughout respiratory phase (IPPV + PEEP)

Indications

1. During general anaesthesia when muscle relaxants are used.
2. To maintain gas exchange in acute and chronic respiratory failure
3. To increase carbon dioxide excretion
4. To reduce work of breathing in cardiorespiratory failure.

5. Medical conditions affecting respiratory function

   eg. myasthenia gravis

   transverse myelitis

   tetanus

   poliomyelitis

6. Postoperative ventilation after cardiothoracic and neurosurgical procedures, as well as in major surgery, otolaryngology procedures, severe sepsis or obese patients when postoperative hypoxaemia is to be avoided

Complications

1. Decreases lung compliance because there is impairment of the surfactant system.

2. Increased V/Q imbalance because greater distribution of inspired gas to the non-dependent lung compared to normal diaphragmatic function which favours gas distribution to gravity dependent segments.

3. Pulmonary barotrauma. This seldom occurs in the absence of pre-existing lung abnormality or chest wall trauma.

4. Decreased cardiac output due to decrease venous return; usually not a problem if blood volume is adequate.

C. Intermittent Mandatory Ventilation

- system which permits a predetermined number of mechanical ventilated breaths, coupled with a system to allow intermittent spontaneous breaths by the patient in between mechanical breaths. A means of weaning adult patients from positive pressure ventilation.

Gas flow during spontaneous breathing phase supported by 2 systems:

continuous flow IMV

demand flow IMV

* *continuous flow IMV maintain a high continuous flow of gas past the patient's airway.*

* *demand flow IMV incorporate a valve which must be patient-activated to provide gas flow with each spontaneous breath;the activation is the negative pressure created as the patient inspires.*

Advantages

1. Avoids respiratory alkalosis.
2. Less sedation required.
3. Decreased likelihood of asynchronous ventilation.
4. Decreased barotrauma risk.
5. More physiological intrapulmonary gas distribution.
6. Faster weaning from mechanical ventilation.
7. Decrease respiratory muscle atrophy or discoordination.
8. Less cardiac and renal dysfunctions.
10. Patient who develop psychological dependence on CMV may cope better.

Disadvantages

1. Carbon dioxide retention may occur if IMV does not respond to changing clinical condition.
2. Increased work of breathing especially in demand flow system. May lead to respiratory muscle fatigue.

4. Danger of 'Breath stacking' which can predispose to barotrauma.

5. Prolonged weaning if IMV rate reduce too slowly.

Synchronised Intermittent Mandatory Ventilation

Modification of IMV whereby the positive mechanical breaths are synchronised to be delivered immediately on initiation of patient's spontaneous inspiratory effort which is sensed by a small negative pressure fluctuation in the breathing circuit. If no inspiratory effort is detected within a certain period, a mechanical breath is delivered.

Mandatory Minute Volume

Modification of IMV where a desired minute volume is preset. The ventilator periodically detects the unassisted patient's ventilation and delivers the difference in minute volume by mechanical breaths. Hence the patient is ensured of a constant level of ventilation despite minute to minute changes in his ability to breathe.

Advantages

1. Ensures a guaranteed level of minute ventilation independent of changes in patient's spontaneous effort during weaning.

2. Said to be especially suitable for patients in whom there may be changing respiratory drive.

Disadvantages

1. Poorly tolerated in patient with rapid shallow breaths, resulting in inadequate ventilation.

ASSISTED VENTILATION

1. Triggered Ventilation

- mode of support whereby patient triggers the onset of a mechanically generated positive pressure tidal volume which is predetermined by the clinician.

- disadvantages include consequences of hyperventilation, increased patient agitation and occasionally exhaustion.

2. Pressure Supported (or assist)

- a constant pre-set positive airway pressure is maintained through out inspiration.

- pressure support ceases beyond a given fraction of inspiration time or when flow falls below a predetemined fraction of the initial inspiratory flow rate.

PEEP AND CPAP

PEEP :defined as residual pressure above atmospheric maintained at the airway opening AT END EXPIRATION.

CPAP :spontaneous ventilation with positive pressure being maintained within the circuit THROUGH-OUT RESPIRATORY CYCLE.

Purpose of CPAP / PEEP Therapy

1. Improve arterial oxygenation

- adequate arterial oxygentation at $FiO_2 < 0.6$ will avoid excessive alveolar oxygen tensions which may alter or depress parenchymal reparative capabilities.

2. Decrease work of breathing - by improvement in lung compliance.

3. Improve V/Q inequality.

Physiological Effects

A. Respiratory Effects

1. Increase Functional Residual Capacity via

   - increase alveolar volume : increase surface exposure between epithelium and capillaries

   - alveolar recruitment

2. Decrease intrapulmonary shunting

3. Improved compliance

   - with increased forced respiratory capacity the compliance of the lung improves and this results in decreased work of breathing.

B. Cardiovascular Effects

1. Decreased venous return because of increased intrathoracic pressure impeding venous return

2. Ventricular dysfunction

   * *increased pulmonary vascular resistance causing increased right ventricular afterload*

   * *PEEP may pressure and volume load the right ventricle, causing a leftward shift of intraventricular septum and a decrease in compliance.*

C. Renal Effects

1. Decreased urine output
2. Sodium retention
3. Water retention

D. Neurological Effect

In patient with decreased compliance or increased intracranial pressure, intracranical pressure may be increased by an amount equal to or greater than PEEP applied.

* **PEEP is indicated when an adequate FiO_2 (generally considered to be 0.6) fails to maintain satisfactory oxygenation (i.e. PaO_2 > 60 mmkg)**
* **usual range of PEEP : 5 - 15 cm H_2O**
* **when the overall margin of likely benefits vs adverse effects from PEEP is unclear, invasive hemodynamic monitoring may be useful. Fluid loading and/ or intropic support may be needed.**

Complications of PEEP / CPAP

1. Pulmonary barotrauma
2. Increased hypoxemia in patients with unilateral lung disease or undergoing one-lung anaesthesia by redistributing blood from normal areas of lung to the diseased
3. Reduced cardiac output from increased intrathoracic pressure and subsequent decreased venous return.
4. Increased intracranial pressure.
5. Fluid retention from reduction in urine output secondary to reduced renal perfusion, redistribution of renal blood flow and increased anti-diuretic hormone secretion.

INVERSED RATIO VENTILATION

* traditionally, inspiratory : expiratory ratios of 1:2 or 1:3 have been used for IPPV in adults.

* in reversing the ratio, inspiratory period is prolonged and appears to have an effect on oxygenation similar to that of PEEP; attributed to increased functional residual capacity by recruitment of previously collapsed alveoli with the prolonged lung inflation.

* usually employed with an inspiratory pressure hold (or plateau phase), low levels of PEEP/CPAP and relatively low ventilator rates.

* disadvantages include depression of cardiac output and pulmonary barotrauma if mean airway pressure rises significantly.

DIFFERENTIAL LUNG VENTILATION

* advocated for selective therapy of lung pathology which is predominantly unilateral.

* with a double-lumen endobronchial tube, selective application of PEEP to one diseased lung may divert a larger fraction of inspiratory gas flow to the less compliant lung so that over-distension of the other relatively healthy and compliant lung is avoided, while at the same time the diseased lung receives extra ventilation assistance.

* inspirations delivered by each ventilator need not be co-ordinated.

HIGH FREQUENCY VENTILATION

* small tidal volume delivered at usually less than the anatomical dead space volume are delivered at higher than normal rates.

* useful in flail chest and patients with compromised cardiovascular function where minimal chest movements and changes in intrathoracic pressure are beneficial.

* in babies with hyaline membrane disease when the lung is stiff and the problem of barotrauma is significant.

WEANING

Assessment Guidelines Before Ventilator Discontinuance

1. Respiratory System

   * clinical improvement in respiratory condition

   * spontaneous respiratory rate < 35 min

   * tidal volume > 5 mls/kg

   * vital capacity > 10 mls/kg

   * maximum inspiratory force > 20 cmH_2O

   * $V_D / V_T < 0.6$

   * if expiratory volume of > 20 L/min required, unlikely patient can maintain this level on his own; if < 10 L/min success of weaning better

   * acceptable arterial blood gas measurements while on the ventilator

   * able to maintain patent airway with intact pharyngeal and laryngeal reflexes

2. Cardiovascular System

   - should be haemodynamically stable

3. Central Nervous System

   - should be in optimal state; drowsiness due to drugs should be corrected

4. Haematology

   - haemoglobin level should be optimised

5. Fluids and Nutrition

- overload will increase the work of breathing and caused respiratory dysfunction. Adequate nutrition is essential to prevent fatigue during weaning

6. Others

- abdominal distension and ileus would cause diaphragmatic splinting

- systemic sepsis or hypermetabolism should be under control

The Weaning Process

1. Pyschological Preparation of the Patient

- explanation and encouragement should be given prior to be weaning process, which is best done in the morning when the patient is most alert

2. Position of Patient

- should be propped up to improve ventilatory mechanics

3. Monitoring

- close monitoring and reassessment of the clinical state of the patient, vital signs, indices of respiratory function, haemo-dynamic and neurological status; trends are more important than actual values

Weaning Techiques

IMV with gradual reduction of ventilator breaths

PSV with gradual reduction of pressure

T-piece trial

ADVERSE EFFECTS OF OXYGEN THERAPY

1. Increased FiO_2 may increase alveolar oxygenation in patient with severe obstructive lung disease removing the hypoxic drive to breathing.

2. High FiO_2 may cause lung units with low V/Q to collapse as a result of uptake of alveolar oxygen which now forms a higher proportion of the alveolar gas, causing absorption atelectasis.

3. Supplemental oxygen may inhibit hypoxic pulmonary vasoconstriction. This will result in blood flow to poorly ventilated regions of the lung and further increase V/Q imbalances and cause absorption atelectasis.

4. In the newborn, retinopathy of prematurity and bronchopulmonary dysplasia has been associated with prolonged oxygen therapy.

* *While it is not clear what constitutes a clincially safe FiO_2, it is established that a FiO_2 of 0.6 or greater may result in oxygen toxicity.*

* *Degree of injury is a function of both lung oxygen tension and duration of exposure.*

* *It is the oxygen tension in the conducting and gas exchange regions of the lung, rather than the oxygen of the systemic blood that is the primary determinant of oxygen toxicity.*

4.4 APPROACH TO MULTIPLE INJURIES (TRAUMA)

Mortality at 3 points in time :

1. Prehospital

   usually unsalvageable (50% of trauma deaths)

2. Within hours of injuries

   haemorrhage, preventable (30% of trauma deaths)

3. Days or weeks after injuries

   Infection and multi-organ failure

PREHOSPITAL PHASE

First Aid Measure

1. Fracture splintage
2. Spinal protection
3. Control of external haemorrhage
4. Control of tension/sucking pneumothorax

Advanced Life Support

1. Airway management including intubation
2. Circulation stabilisation
   - MAST suit

- fluid resuscitation

3. Brain resuscitation

* In urban areas where hospitals are near, "scoop and run" policy should be practised. The only measures will be directed towards securing airway and protecting the neck.

HOSPITAL PHASE

Accident & Emergency Department

PRINCIPLES OF MANAGEMENT

Simultaneous primary assessment and resuscitation

Complete physical examination (secondary survey)

Monitoring of resuscitation

Diagnostic investigations

PRIMARY ASSESSMENT AND RESUSCITATION

1. airway
2. circulation
3. brain resuscitation

* Improvement on measures initiated at accident site.
* Look for pneumothorax, open chest wounds, flail chest, cardiac tamponade - amenable for immediate correction
* If airway difficult to secure - consider intubation or cricothyrotomy (needle cricothroidectomy for children under 12 because cricoid cartilge is important for tracheal support in this age group).
* Use wide-bore cannulas (14G) for fluid resuscitation. Consider need for MAST (Medical Antishock Trousers).

- Use group-specific unmatched blood rather than universal blood.
- 15 - 20% blood loss = Bld pressure drop
  30% blood loss = BP 60 - 80 mmHg
  40% blood loss = BP below 50 mmHg
- Consider need for colloid solutions early.
- If cerebral oedema suspected, start mannitol and corticosteroids.

SECONDARY SURVEY

1. thorough examination
2. diagnostic tests (abdominal lavage, CT scans, etc)
3. trauma scale scoring

- examination must be thorough and subtle clinical signs noted eg. abdominal bruising, scalp injuries, etc.
- in unconscious patients, assume unstable cervical spine injuries unless proven otherwise.
- radiological priorities : cervical spine, chest and pelvis
- decision for transfer to operating theatre, intensive care unit, general ward or specialised trauma centre will be decided after completion of this phase of management.

MONITORING

1. Adequacy of fluid resuscitation
   - pulse rate and blood pressure
   - central venous pressure
   - capillary refill
2. Adequacy of respiratory resuscitation
   - arterial blood gas
   - pulse oximetry
3. Guide to organ perfusion
   - urine output (at least 0.5 ml/min)

- mental state

4. Conscious level

   - Glasgow Coma Scale

Problems at this stage

1. Failure of thorough and detailed examination and documentation
2. High index of suspicion needed for occult injury in the presence of associated injuries.
3. Failure to intubate and ventilate patients early.
4. Complications of emergency procedures (CVP, urinary catheterisation, chest tube)
5. Complications of blood transfusion.

Operative Phase

Control of haemorrhage

Relief of increased intracranial pressure

Debridement of devitalised tissue

Repair of soft tissue

Fracture stabilisation

* the surgical priorities are in order of listing :

Intracranial bleeding

Injuries to torso

Peripheral vascular injuries

Orthopaedic injuries

Maxillofacial injuries

* lack of recognition of need for surgical intervention and / or delay in surgical management are the leading causes of post-traumatic morbidity and preventable deaths

* simultaneous surgery by separate surgical teams saves operative time and anaesthesia which may be critical in postoperative recovery

* need for emergency surgery must be differentiated from urgent surgery where in the latter, stabilisation of the patient can be afforded. In emergency surgery, intervention is needed to stabilise the patient eg. splenectomy for a ruptured spleen to stop the haemorrhage.

Intensive Care Phase

Severely injured patients

Postoperative patients

Problems :

1. Sepsis
2. Immunosuppression
3. Multiple organ failure
4. Wound complications
5. Surgical nutrition
6. Cerebral oedema

* Sensitive indicator of perfusion is base excess; worsening or failure to improve indicate continuing haemorrhage or inadequate resuscitation.

* Septic risk over when T-suppressor to T-helper cell ratio reverts to normal.

* Minor surgical procedures in A & E rooms are usually performed in less than ideal aseptic conditions; hence routine removal and replacement of all intravenous lines will help reduce septic catheter complications.

Rehabilitation Phase

Functional

* physiotherapy
* occupational therapy

Cosmetic

* reconstruction
* body image (prosthesis)
* Pyschosocial
* pyschiatrist
* family members and friends
* spiritual help

TRAUMA SCORING

Identify severity of trauma

Predict prognosis and extent of recovery

Guide management

As an audit of trauma care

Anatomical Scoring

Injury Severity Score (ISS)

Abbreviated Injury Score (AIS)

* assess injury in 6 anatomical areas - head and neck, face, chest, abdomen and pelvic contents, bony pelvis and limbs, and body surface

* score of 0 to 6

  0 = no injury

  1 = minor injury

  2 = moderate injury

  3 = severe injury (not life-threatening)

  4 = serious injury (life-threatening, survival probable)

  5 = critical injury (survival uncertain)

  6 = maximum injury (currently untreatable)

* ISS obtained by adding square of 3 highest scores from separate area.

Disadvantages

1. Unsuitable for assessment at scene of injury or arrival in hospital

i.e. it is a retrospective score done post-treatment.

2 ? applicable to blunt and penetrating trauma.

Neurological Scoring

Glasgow Coma Scale

* assess 3 neurological functions - eye opening, best motor response and best verbal response
* score of 7 or less = coma. Usually means complete recovery not likely, may need dependent care.
* score of 13 or more = complete recovery likely
* score of 7 or less at hospital admission should prompt the need to secure airway and institute brain resustation.

Eye-opening response	**Spontaneous**	4
	To voice	3
	To pain	2
	None	1
Best verbal response	**Oriented**	5
	Confused	4
	Inappropriate words	3
	Incomprehensible sounds	2
	None	1
Best motor response	**Obeys command**	6
	Localises pain	5
	Withdraws (pain)	4
	Flexion (pain)	3
	Extension (pain)	2
	None	1
Total		3 - 15

Physiological Scoring

Revised Trauma Score (RTS)

* assess the physiological consequences of injury
* obtained by combining Glasgow Coma Scale, systolic blood pressure and respiratory rate
* more sensitive grading system
* RTS of less than 12 or Glasgow Coma Scale of less than 13 should be managed in a trauma centre

	Coded value	x weight	= score
Respiratory rate (breaths/min) :			
10 - 29	4		
> 29	3		
6 - 9	2	0.2908	_____
1 - 5	1		
0	0		
Systolic blood pressure (mmHg) :			
> 89	4		
76 - 89	3		
50 - 75	2	0.7326	_____
1 - 49	1		
0	0		
Glasgow coma scale :			
13 - 15	4		
9 - 12	3		
6 - 8	2	0.9368	_____
4 - 5	1		
3	0		_____

Total = revised trauma score : _____

TRAUMA CENTRES

A system of trauma centres has reduced preventable deaths from trauma in Orange County, California, USA from 73% to 9%. It is recognised that a well-organised trauma management system providing optimal care at each stage of the management is the way to minimise mortality and morbidity.

A trauma team should include :

an experienced surgeon well versed in trauma manage

junior surgical staff with defined duties

radiographers

trauma-trained nursing staff

the following specialists available for consultation at short notice :

neurosurgeon

radiologist

urologist

cardiothoracic surgeon

paediatric surgeon

SUGGESTED READINGS

D Skinner, P Driscoll and R Earlam (eds) (1991) ***ABC of Major Trauma.*** **United Kingdom, Bristish Medical Journal.**

American College of Surgeons Committee on Trauma (1993) ***Advanced Trauma Life Support Course for Physicians,*** **5th ed. Chicago, American College of Surgeons.**

4.5 HYPOTENSION IN SURGERY

Shock - defined as the haemodynamic state where tissue perfusion is inadequate.

Clinical Types

Cardiogenic

Neurogenic

Hypovolaemic

Septicaemic

Anaphylactic

* in surgical practice, hypovolaemic and septicaemic shock are the most commonly encountered types.

Physiology of Cardiac Muscular Function

Three considerations :preload

cardiac contractility

afterload

Preload

Frank-Starling Law : the greater the heart is filled during systole the greater will be the quantity of blood pumped into the aorta (up to a limit)

Contractility

ability of ventricular muscle to generate pressure at a constant preload
It can be influenced by positive inotropic drugs like adrenaline, dopamine.

Afterload

determined by systemic resistance. Changes in afterload will alter the ventricular pump function by enhancing ejection if afterload is decreased or impeding ejection if afterload is increased.

Preload =	left ventricular end-diastolic pressure or PCWP
Afterload =	systolic arterial pressure
Contractility =	ejection fraction : $EF = \frac{EDV - ESV}{EDV}$
	where EDV - end diastolic vol
	ESV - end systolic col
	normal EF > 60 %

HYPOVOLAEMIC SHOCK

* *problem of inadequate preload with a fairly normal heart and a physiological response of increased afterload.*

Causes :

- haemorrhage
- burns
- dehydration

I Haemorrhagic Shock

Classification of hypovolaemic shock according to blood loss				
	Class I	Class II	Class III	Class IV
Blood loss :				
Percentage	< 15	15 - 30	30 - 40	> 40
Volume(ml)	750	800 - 1500	1500 - 2000	> 2000
Blood pressure :				
Systolic	Unchanged	Normal	Reduced	Very low
Diastolic	Unchanged	Raised	Reduced	Very low or unrecordable
Pulse (beats/min)	Slight tachycardia	100 - 120	120 (Thready)	> 120 (Very thready)
Capillary refill	Normal	Slow (>2s)	Slow (>2s)	Undetectable
Respiratory rate	Normal	Normal	Tachypnoea (>20/min)	Tachypnoea (>20/min)
Urinary flow (ml/h)	>30	20 - 30	10 - 20	0 - 10
Extremities	Colour nonmal	Pale	Pale	Pale and cold
Complexion	Normal	Pale	Pale	Ashen
Mental state	Alert	Anxious or aggressive	Anxious, aggressive,or drowsy	Drowsy, confused, or unconscious

Fluid Resuscitation

A. Choice of 1. Crystalloids - Hartmann's

Normal Saline

2. Colloids - Natural : Pooled Plasma

Fresh Frozen Plasma

Human Albumin

- Synthetic : Dextrans

Gelatins

Hydroxy-ethyl starches

3. Blood - Bank blood

Fresh blood

4. Others - Haemoglobin solutions

Perfluorocarbons

* blood is the mainstay of resuscitation but should not be considered ideal because bank blood is not the same as circulating blood and fluid loss is not merely from plasma space.

* human albumin solution is generally considered inappropriate.

* Hb solutions are manufactured from human and bovine blood; does not contain 2, 3 DPG and so are inefficient oxygen carriers.

* perfluorocarbons carries oxygen in physical solution in contrast to chemical reaction in cases of haemoglobin.

* dextrans interfere with cross-matching and hence blood should be taken for GXM before transfusion with dextrans. Also interferes with coagulation.

* gelatins contains calcium (Haemacel) and can cause precipitation if mixed with citrated blood.

* hydroxyethyl starches cause prolonged bleeding time and is expensive.

B. Suggestion for usage of fluids

* initial mixture of crystalloids and colloids in the ratio of 2:1

* when blood loss estimated to be > 1.5 L, consider blood transfusion.

* keep haematocrit over 25%.

Properties of An Ideal Transfusion Fluid

1. able to replenish volume depletion in plasma, interstitial and intracellular spaces
2. metabolically inert
3. no antigenicity
4. does not transmit infection
5. less than 25 % excreted in 24 hours, but not retained indefinitely
6. consistent and cheap
7. long shelf life
8. compatible with other transfusion fluids
9. viscosity not influenced by temperature
10. no influence on haemostasis when replacing at least 1/3 blood volume
11. no influence on oxyhaemoglobulin dissociation curve
12. able to transport oxygen

MANGEMENT

1. Assessment of Intravascular Volume
    - central venous pressure
    - pulmonary capillary wedge pressure
2. Assessment of Haemodynamic Status
    - pulse rate
    - blood pressure

3. Assessment of end-organ function

   - urine output

   - mental status

4. Mainstay of Treatment - Fluid Resuscitation

* **Type of fluid given initially is less important than the need for its urgent and rapid transfusion i.e. volume expansion is the priority.**
* **Oxygen transport can be adequately undertaken by the diluted blood, indeed there may be some advantage in having haemodilution because blood viscosity falls and rbc passage through microcirculation improves with better oxygen delivery to the tissues.**
* **Replacement of rbc becomes important only when haematocrit falls below25%.**

II Burn Shock

PROBLEM OF :

* *hypovolaemia from losses through burn wound*
* *increased capillary permeability*
* *myocardial depressant factor*

Fluid Resuscitation :

1. many formulae but basically aim to predict both insensible losses and the total amount of fluid sequestrated into the burn wound.
2. greatest loss occurs during 8 - 12 hours postburn and then continues more slowly over next 12 - 16 hours.
3. return of normal haemodynamic status depend only on rate of fluid replacement.

4. because of capillary permeability, colloids of no benefit in immediate postburn period, in fact may be harmful because they get sequestrated in tissue spaces when permeability returns to normal and thence drains fluid out of vascular space.

5. in children, plasma has the advantage of providing passive immunisation; so 1/4 of their burn fluid replacement should be plasma.

Parkland Formula :

Total fluid over initial 24 hours postburn =

4 mls x BW in kg x % total BSA of burn

- *1/2 of total given over first 8 hours*
- *1/4 of total over each of 2 remaining 8 hours*
- *solution suggested = balanced salt solution*

Pratt Formula :

1st 24 hrs - 2 mls/kg BW/% BSA burn of lactated ringers' solution. 1/2 of total in first 8 hours.

2nd 24 hrs - 0.3 - 0.5 ml/kg/% BSA burn of plasma or plasma substitute.

Adequacy of Replacement Signalled By :

1. lucid sensorium
2. pulse rate less than 120/min
3. satisfactory urinary output of 0.5 - 1 ml/kg/hr
4. clearance of haemoglobinuria within 2 - 3 hours

5. decreased urinary specific gravity
6. haematocrit of less than 60%
7. improvement and stabilisation of blood pressure and pulse rate
8. stabilisation of CVP between 5 - 12 cm water

   PWCP between 10 - 15 cm water

SEPTICAEMIC SHOCK

- Haemodynamic instability caused by endotoxaemia

Problem of :

* *increased capillary permeability (leading to intravascular hypovolaemia)*
* *myocardial depressant factors*
* *vasodilatation (decreased vascular resistance)*
* *multiple organs failure*

Organisms Implicated

- all organisms have been implicated
- G-negative bacteria accounts for 65 - 75%; due to unique 3 - layered lipopolysaccharide cell wall (endotoxin)
- about 10 - 20% are polymicrobial

Predisposing Factors

1. Metabolic Disorders
   * diabetes mellitus

* chronic uraemia
* cirrhosis

2. Blood Disorders
   * leukaemias
   * reticulosis
   * congenital immune disorders
3. Immunocompromise
   * steroids
   * disseminated malignancies
   * antimitotic agents
4. Poor Health
   * malnutrition
   * elderly

Predisposing Surgical Conditions

1. Upper Urinary Tract Infection
2. Infection of the Biliary Tree
3. Burns
4. Gynaecological infections
5. Intra-abdominal sepsis including overgrowth of gut organisms in intestinal obstruction
6. Manipulation or instrumentation of urinary tract,biliary tract(ERCP)

Clinical Manifestation

TWO FORMS :

1. *Hyperdynamic state in a normovolaemic patient (warm shock)*

* increased cardiac output
* decreased peripheral resistance
* hypotension
* normal or increased central venous pressure
* hyperventilation
* respiratory alkalosis
* warm dry extremities

2. *Hypodynamic state in a hypovolaemic patient from overt blood loss or overt third space loss (cold shock)*

* decreased cardiac output
* increased peripheral resistance
* hypotension
* decreased central venous pressure
* cold, cyanotic extremities

PRINCIPLES OF MANAGEMENT

1. Correct/optimise predisposing factors
2. Surgical removal of septic focus
3. Appropriate antibiotics therapy
4. Support failing organs or systems (cardiac, respiratory (ARDS), liver, renal, coagulation)

Support of Cardiovascular Dysfunction

Order of Priority would be :

1. fluid resuscitation
2. cardiogenic support
3. correction of afterload

* proceed to next priority only if blood pressure is still low after optimising the preceding factor

1. FLUID RESUSCITATION

* studies in Israel's wars showed septic shock patients require 5 - 10 L of crystalloid fluids to resuscitate.

* Crystalloid vs colloids

argument against crystalloids is that the increased capillary permeability can precipitate pulmonary oedema compared with colloids which tend to stay in the vascular compartment; however it can also be argued that pulmonary oedema may be more protracted and refractory to treatment if treated with colloids because in the face of increased capillary permeability even colloids can get out into the interstitial space.

2. CARDIOGENIC SUPPORT

Dopamine

* β effects on the cardiac muscles

* also has renal vasodilatation effects that are mediated by dopaminergic receptors

* keep dosage below 15 ug/kg/min to avoid vasoconstrictive effects (α effects at high dosage)

Dobutamine

* " inotrope of first choice "
* β effects with β-mediated vasodilatation
* less chronotropic activity
* less tendency to cause arrhythmias
* dose range from 2 - 20 ug/kg/min
* can use in combination with dopamine

Adrenaline

* cause marked increase in cardiac work and oxygen
* arrhythmogenic
* most potent and hence agent of choice in cardiac arrest
* dose range from 0.06 - 0.18 ug/kg/min

Noradrenaline

* use only in extreme circumstances
* strong vasoconstrictive property

Amrinone

* weak inotropic effect
* also cause vasodilatation and therefore useful in cold shock

Digitalis

* arrhythmogenic in the presence of electrolyte imbalances expecially hypokalaemia

* narrow therapuetic window and hence dosage must be adjusted and serum level closely monitored in renal impairment

3. CORRECTION OF AFTERLOAD

In warm shock, vasodilatation prominent, so give vasopressors :

Ephedrine

Phenylephrine

Metaraminol

Noradrenaline

In cold shock, vasoconstricted, so give vasodilators :

A. *Direct Acting*

Nitroprusside

* *rapid, short-acting potent drug; hence requires continuous infusion. Allows for easy control by titration*

* *acts directly on arterioles*

* *can cause severe hypotension*

* *direct arterial pressure monitoring required*

Nitrates

* *relaxes arteriolar smooth muscle*

* *however they cause venous dilatation and pooling resulting in fall in preload*

Hydralazine

* *most widely used direct vasodilator drug*

* *effects relatively prolonged*

Nifedipine

* *calcium antagonist*

* *cause arterial smooth muscle relaxation*

B. Indirect Acting

α- blocking drugs

phentolamine

chlorpromazine

*** Adequate pre-load must be ensured before instituting vasodilator therapy Systolic blood pressure should be at least 90 mmHg**

4.6 BLOOD TRANSFUSION

The aim of blood transfusion is to ensure adequate tissue perfusion and oxygen carriage.

A. Blood transfusion should not be considered only in terms of volume replacement with whole blood; this is wasteful and harmful.

B. Stored blood is depleted in quantity and quality of many other blood components.

C. Blood components therapy should be advocated as often as possible.

Types of Blood Products

1. Whole Blood

   * *Superfresh blood - non-refrigerated blood transfused within hours of collection.*

   * *Fresh blood - ACD or CDP blood stored for 24 hrs and containing adequate conc of all components.*

   * *Bank blood - ACD or CDP blood.*

2. Packed Cells - haematocrit of > 70 %.

3. Plasma-reduced blood - haematocrit 60 - 65%.

4. Washed, resuspended red cells - for those allergic to donor's plasma.

5. SAG (M) - derived from whole blood; plasma replaced by saline/ adenine/glucose/mannitol.

6. Blood Components

   Leucocytes

   Platelets

Plasma and its constituents

Fresh frozen plasma

Plasma protein fraction

Human albumin BP

Clotting factors conc - cryoprecipitate

Immunoglobulins

Clinical Indications of Blood and Blood Product Transfusion

Fresh whole blood

- massive acute haemorrhage requiring transfusion of all blood components.

Bank whole blood

- acute haemorrhage.
- not apporpriate for modest blood loss.

Packed red cells (haematocrit > 70%)

- normovolaemic anaemia.

Plasma reduced blood (haematocrit 60 - 65%)

- acute haemorrhage.
- may be supplemented with specific blood components.

Washed, resuspended red cells

- as for plasma reduced blood for patients reacting to donor plasma
- rarely required

SAG (M)

- replacing plasma reduced blood for modest acute haemorrhage.

Plasma protein fraction (PPF) (45%)

- burns, crush injury, plasma exchange.
- effective as plasma expander in hypovolaemic shock, but see text.

Human albumin B.P. (5% and 20%)

- 5% solution used as plasma protein fraction
- 20% solution used for hypoalbuminaemia.
- not indicated in hypovolaemic shock.

Platelet Concentrates or Plateletpheresis

- active bleeding with bleeding time > 2X normal
- active bleeding with platelet count < 20,000 (nonsurgical conditions)
- active bleeding with platelet count < 60,000 (surgical conditions)
- active bleeding following complete heparin neutralisation

Fresh Frozen Plasma

- isolated factor deficiencies
- reversal of warfarin effect
- massive blood transfusion (see later section)
- antithrombin III deficiency
- immunodeficiencies (passive transfer of immunity)
- thrombotic thrombocytopenic purpura
- coagulopathy

Complications of Blood Transfusion

GENERAL

1. Febrile reactions - leucocyte incompatibility

2. Bacterial contamination - endotoxaemic shock

3. Immune reactions -

   haemolytic : ABO incompatibility

   non-haemolytic : alloimmunisation to leucocyte and platelets

4. Physical -

   pulmonary embolism from leucocytes/platelet aggregates

   thrombophlebitis

   air embolism

5. Disease transmission -

   viral : hepatitis, AIDS

   bacterial : syphilis, brucellosis

   parasites : malaria

MASSIVE BLOOD TRANSFUSION - see next page

MASSIVE BLOOD TRANSFUSION

-administration of more than 1 - 1/2X patient's blood volume

Problems

1. STORAGE LESIONS

* Coagulation abnormalities

- decreased coagulation factors especially V and VIII factors.
- decreased platelet count and function
- hypocalcaemia
- dilutional effect

* Impaired oxygen carriage

- decreased 2, 3 Diphosphoglycerate
- increased acidosis with right shift of oxygen dissociation curve

* Acid-base abnormality
* Citrate toxicity
* Hypothermia
* Microaggregates
* Impaired rbc deformability
* Impaired bacterial defences
* Sodium overload
* Infusions of plasticiers,denatured protein, vasoactive substances

2. VOLUME RELATED

* Volume overload

* Jaundice from haemolysis of transfused rbc

* Disease transmission - probability increased

* Immunologic Mismatch - probability increased

Prophylactic Measures Suggested

1. One pint fresh blood after every 4 pints bank blood transfused or 1 pint FFP for every 5 pints bank blood transfused.
2. 10 mls of 10% Ca gluconate for every 5 pints blood transfused if serum calcium is low.
3. Blood filters.
4. Warm blood before administration.
5. ? platelet replacement

MEASURES APPLICABLE FOR ELECTIVE SURGERY

1. Autologous Transfusion

* blood extracted from patient 2 weeks before surgery, stored and ready for transfusion if needed.

* eliminates risk of transfusion infections and incompatibility reactions.

* criteria similar to that for blood donation.

2. Cell Saver

Blood lost during surgery filtered and returned to patient

Applicable only in :

* clean operations
* GI tract and other sites with resident bacterial flora not opened
* not suitable for malignant conditions

Indicated in :

* vascular surgery eg. repair of aortic aneurysm
* neurosurgical procedures
* limb surgery eg. total hip/knee replacement

RECOMMENDED READING

Gravlee GP : *Blood Transfusion and Component Therapy.* In : 1989 Annual Refresher Course Lectures. American Society of AnaesMesiologists, USA

4.7 ADULT RESPIRATORY DISTRESS SYNDROME

This is a clinical syndrome resulting from acute injury to the lung, characterised by breakdown of the normal barrier to leakage of fluid out of the pulmonary capillaries into the interstitium and alveolar spaces.

Pathophysiology

Increased permeability of capillary endothelial cell and alveolar epithelial cells

↓

Leakage of high protein fluid

↓

Hyaline membrane formation

Theories of Increased Capillary Permeability

1. Neutrophil-derived injury via superoxide and proteolytic enzymes
2. Coagulation-derived injury

Aetiological Factors

1. Inhaled injurious agents
   - liquid - gastric contents, salt water
   - aspirated hydrocarbons
   - toxic gases eg. pure oxygen
   - infectious agents eg. viruses

2. Injury via Pulmonary circulation

- sepsis
- disseminated intravascular coagulation
- fat or amniotic fluid embolism
- drugs eg. heroin
- acute pancreatitis
- disorders of central nervous system eg. trauma
- massive blood transfusion

Pathological Effects

1. Ventilation / Perfusion imbalances
2. Alteration in function of surfactant
3. Increased pulmonary vascular resistance
4. Decreased compliance
5. Decreased functional residual capacity

Clinical Features

1. Dyspnoea, Tachypnoea
2. Rales
3. Decreased PO_2, normal or decreased PCO_2
4. X-Rays - interstitial and alveolaroedema

HYPOXEMIA is the hallmark of ARDS and is defined as oxygen tension of less than 70 mmHg while on FiO2 of 40% via ETT.

MANAGEMENT

1. Aggressive pulmonary toilet

2. Oxygen therapy

3. Fibronectin (found in fresh frozen plasma)

4. ? Antibiotics

5. PEEP
   - Corrects hypoxemia
   - reverses progressive alveolar collapse
   - decreases interstitial oedema
   - improves alveolar gas exchange
   - increases PaO_2

4.8 SURGICAL NUTRITION

50% of surgical patients were found malnourished by one or more parameters

- Bistrain, 1974

Clinical Significance

* substandard nutritional status has been shown to correlate with increased post-operative morbidity and mortality

* Willcuts and Buzby have shown significant increase in nosocomial infection in patients with poor nutritional status

Nutritional Assessment

1. History - recent weight loss
   diet
   socioeconomic status
   home environment
2. Clinical - thin, sparse hair
   spooned or ridged nails
   dry, scaling or rough skin
   dull, listless eyes
   angular stomatitis or cheliosis
   glossitis
   swollen, bleeding gums

generalised muscle wasting

oedema

4. Anthropometric studies - body weight for height

triceps skinfold

mid upper arm circumference

5. Laboratory studies- serum albumin

serum transferrin

thyroxine-binding prealbumin

retinol-binding protein

nitrogen balance

total lymphocyte count

delayed hypersensitivity skin tests

PROGNOSTIC NUTRITIONAL INDEX (PNI)

PNI (%) = 158 - 16.6 (alb) - 0.78 (TFN) - 5.8 (DH)

where alb = serum albumin (g/dl)

TSF = triceps skinfold (mm)

TFN = serum transferrin (mg/dl)

DH = delayed hypersensitivity reactivity

to any of 3 antigens, graded as

0 : non-reactive

1 : 5 mm induration

2 : 5 mm induration

Using the PNI to predict operative risk :

PNI 30% = low risk

30% PNI 60% = moderate risk

PNI 60% = high risk

PHYSIOLOGICAL RESPONSES TO NUTRITIONAL DEPRIVATION

Non-Stressed Starvation

- overall fuel conservation with preservation of body protein

1. decreased glucose utilisation by central nervous system with increased utilisation of ketones
2. decreased gluconeogenesis
3. increased fat mobilisation
4. decreased basal metabolic rate

Two phases of response :

1. First week :

   increased glucose production

2. Adaptive phase :

   increased fat oxidation

decreased gluconeogenesis

decreased basal metabolic rate

* "protein-sparing" effect of glucose. Low dose carbohydrate is better than fat in this respect.
* glucose admimistration alone can reverse the metabolic response.

Stressed Starvation

- *HYPERMETABOLISM with high circulating substrates at the expense of body-tissue stores*

1. there is an increased need for glucose in response to stress (for wound healing, combating infections); gluconeogenesis is increased with protein breakdown.
2. increased fat mobilisation and oxidation to meet the increased energy demands of tissue not dependent on glucose; lipid oxidation accounts for the majority of oxidative substrate utilisation.
3. impaired glucose utilisation by skeletal, cardiac and respiratory muscles
4. greater oxidation of glucose, but there is an upper limit of 6 mg/kg/min.

* the normal pattern of fat mobilisation does not reverse readily by nutritional support unlike in non-stressed starvation. Hence hypertonic glucose dosages are usually ineffective and can pose an additional stress by increasing oxygen consumption, carbon dioxide production and inducing hepatic dysfunction.
* the nutritional requirement for stressed starvation would include relatively modest concentration of glucose with amino-acides, and fat for increased energy requirement; because there is impaired glucose utilisation so that high dosage of glucose is not useful and can be harmful.
* advanced-stage sepsis is characterised by decreased fat and glucose utilisation i.e. general metabolic failure; hence it is important that for nutritional support to be effective, it must be instituted early rather than late.

INDICATIONS FOR INSTITUTING NUTRITIONAL SUPPORT

Pre-operative Factors

- serum albumin less than 3g/dl

- unintentional weight loss of more than 10% of usual body weight AND/OR

- skin test anergy

Regime : 30 - 45 kcal/kg/d and 1.2 - 1.5g/kg/d of protein for at least 7 - 10 days

Post-operative Factors

Weight loss of more than 20% when he was well and there is no immediate prospect of his eating normally soon.

Disease Conditions

- GI indications
  - * mechanical obstruction
  - * short bowel syndrome
  - * inflammatory bowel disease
  - * intestinal fistulae
  - * pancreatitis
- burns
- injured-septic patients
- comatose patients

NUTRITIONAL REQUIREMENT

1. Calculated as NORMAL REQUIREMENTS + ABNORMAL NUTRITIONAL NEEDS + DEFICITS REPLACEMENT (if patient starts off under-nourished).

2. Ideally, caloric requirements given in ratio of 60 - 65% carbohydrate, 25% protein and 15% fat.

In stressed states, glucose utilisation is impaired and excessive glucose can cause more harm (see section on Physiological Response to Nutritional Deprivation); lipid as alternative energy source should be considered.

Normal Requirements

Water	30 - 50 mls/kg
Calories	30 - 50 kcal/kg
Protein	Calories x 0.04g (150 kcal : 1g Nitrogen)

Electrolytes

Sodium	100 - 150 mmols
Potassium	80 - 100 mmols
Calcium	5 mEq/1000 kcal
Magnesium	8 mEq/1000 kcal
Phosphate	10 mEq/1000 kcal

Vitamin cocktail

Vit K	10 mg
Folate	15 mg

(given at least once weekly)

Role of lipid :

1. essential fatty acid (linolenic acid) required for normal metabolism

2. allows for better protein assimilation

3. prolonged fat deficiency causes lowering of body resistance to bacterial infection, however consumption of omega-6 fatty acids in Intralipid solution leads to production of PGE2 and possible immunosuppression (a restriction of omega-6 lipids to 20% of non-protein energy intake is recommended in critically ill patients)

4. provides 9 kcal/g compared to 4 kcal/g provided by glucose and protein

* should at least give 1 L Intralipid 2X weekly for prolonged TPN if not given as part of daily infusion (intralipid is expensive and may not be given daily because of cost consideration)
* hepatotoxicity by current intravenous fat emulsions is not proven

Abnormal Nutritional Needs

Wilmore's Tables :

Postop state	add 5%
Peritonitis	15 - 30%
Severe infection	30 - 55%
Multiple Trauma	30 - 55%
30% Burns	70%
50% Burns	100%
70% Burns	115%

Deficits :

Add 1000 kcal and 40g protein

MODES OF NUTRITIONAL SUPPORT

Enteral

Parenteral

Combination of both enteral and parenteral

Enteral Feeding

Preferred in most instances because :

1. 70% of intestinal mucosal nutrition are derived from intraluminal source and only 30% from systemic circulation
2. trophic effects of intraluminal nutrients on intestinal epithelium
3. intraluminal nutrients are necessary for maintenance of intestinal mucosa integrity to prevent bacterial translocation from intestinal lumen
4. maintainance of mucosal IgA secretions
5. better assimilation of nutrients
6. substrate-induced metabolic regulation by gut hormones is important eg. insulin release by parenterally administered glucose can cause hypoglycemia whereas that by gut-absorbed glucose is modulated by enteroglucagon
7. better support of gut commensals
8. less costly
9. less incidence of metabolic complications

Types of Feeding

Supplemental

Full - meal replacement

Types of Feeding Modules

Type 1	Type 2	Type 3
Basic, high-molecular formula	Modified, high-molecular formula	Chemically defined, low-molecular formula
Complete protein	Complete protein	Defined oligopeptide (few amino acids)
Polysaccharides	Polysaccharides, lactose-free	Oligosaccharide
LCT-fat	MCT-enriched	MCT and essential fatty acids

LCT = long-chain triglycerides; MCT = medium-chain triglycerides.

Type 1 - requires normal digestive and absorptive capacity
Type 2 - reduced digestive and absorptive capacity of patients with nutritional deficits
Type 3 - can be absorbed even at minimal digestive capacity eg. severe pancreatic insufficiency; sprue

(M Heberer and F. Harder)

Delivery

1. Oral

2. Nasogastric/nasointestinal

3. Gastrostomy

4. Jejunostomy

* *For nasogastric route, most patients will tolerate application of macrobolus infusion 4 - 6 times daily. Occasionally in high calorie demands or need for maximal reduction of stool frequency in burn patients, continual pump-controlled administration is advantageous. Small-bore tubes are used for comfort as well as to reduce upper gastrointestinal complications and control rate of administration to prevent regurgitation.*

* *Intestinal feeding require initial phase of adaptation and pump-controlled infusion. Type 3 formulations is indicated.*

Potential Complications of Jejunostomy Feeding

1. Catheter-related complications

Leakage or breakage of catheter

Obstructed catheter lumen

Abscess at catheter exit site

Accidental catheter removal

Intra-abdominal dislocation of catheter tip

Small bowel obstruction

2. *Metabolic complications*

Glucose intolerance

Electrolyte imbalances

Dehydration from diarrhoea

3. *Gastroenterological complications*

Reflux, vomiting, aspiration

Abdominal distention, dumping, diarrhoea

4. *Rare complications :*

Complicated jejunal varicosis

Pneumatosis intestinalis

Necrotizing enterocolitis

Parental Nutrition

Central line, glucose-based/lipid-based TPN

Peripheral line, lipid-based TPN

Protein-sparing therapy

A. CENTRAL LINE, GLUCOSE-BASED I/V HYPERALIMENTATION :

- Pharmacy-prepared bags (21, 31)

- Order individual nutrients

* Central veins required because of the high osmolality of the solutions. Internal jugular or subclavian veins usually used. Femoral veins may be used but femoral thrombosis is a serious complication. Creation of a subcutaneous tunnel may allow for prolonged use.

* The central line for TPN should be kept only for such use and not used for other parenteral administration eg. antibiotics.

* New feeding tubes can be inserted peripherally and then threaded into central veins.

* Constant rate of administration by infusion pump required so that there is no sudden surges of glucose infusion which can precipitate polyuria or even hyperosmolar coma. Similarly, administration must be introduced gradually and tailed off when stopping. Insulin may be required initially and in some cases, throughout the period of parenteral alimentation.

* The aim is for nitrogen equilibrium. There may be a need to achieve positive nitrogen balance in the nutritionally-depleted patient but hyperalimentation is not encouraged unless strictly indicated. There is impaired glucose utilisation in the stressed state and high glucose dosage can cause more harm than good (see section on Physiological Responses to Nutritional Deprivation).

* There is no discernable differences in the nitrogen balances achieved with "glucose system" TPN (all non-protein calories supplied in the form of glucose) compared to "lipid system" TPN (equal portions of non-protein caloric load supplied as glucose and fat). However, there is reduction in carbon dioxide production in the "lipid system" and hence may be more appropriate for the stressed patients with respiratory compromise.

* Glutamine is involved in many normal physiologic processes including renal regulation of acid-base balance, respiratory fuel for certain tissues and maintainence of function of lymphocytes, marcophages, thymocytes and gastrointestinal cells. There should be increased use of glutamine in nutritional support.

* Arginine has been shown to increase T-helper cell function and increase the lymphocyte content of the thymus. However, its role has not been clearly defined.

* Home TPN is a possibility where good community medical support is available.

B. LIPID-BASED, PERIPHERAL LINE TPN

INDICATIONS

Absolute :

1. Not possible or necessary to insert CVP line.
2. Paediatric age group where hypertonic dextrose solutions in central line is undesirable.
3. IDDM patients (same reason as in 2)

Relative :

1. Delay in CVP insertion.
2. Presence of thrombosed subclavian veins.
3. Technical difficulty or danger involved in CVP insertion.
4. Repeated history of septic episodes.
5. Need for parental supplementation for patients receiving suboptimal oral nutrition.
6. Short-term requirements for nutritional support.

DISADVANTAGES :

1. Several adequately size peripheral veins required.
2. Not suitable in the stressed or hypermetabolic patients.
3. Peripheral veins can only accept up to 600 mOsm solution.
5. Not recommended for long-term TPN or those who need complete nutritional replacement.

C. PROTEIN-SPARING THERAPY

Applicable *in those patients with mild nutritional deficits or in whom a short period of starvation is anticipated.*

Blackburn et al (1973) :

Infusing amino-acids alone, without any non-protein energy in surgical patients resulted in reduction in degree of negative nitrogen balance.

Greenberg and Leejeebhoy (1979) :

Amino-acid intake of 2g/kg BW/day increased protein-sparing with a positive nitrogen balance even though the energy needs of the patients were not met.

Young and Hill (1980) :

Infusing amino-acids alone and TPN for protocolectomy and AP resection, showed no difference in total body measurements of nitrogen and potassium with comparable morbidity rates.

Ulrich Keller et al (1986) :

Amino-acids are better than glucose in improving post-operation nitrogen balance. Addition of glucose does not significantly increase nitrogen retention with amino-acids alone.

* *Protein-sparing therapy does not provide as complete or effective nutri - tional support as compared to TPN especially for long term or patients with increased metabolic requirements. However, it is a* simple, safe and *effective means of short-term nutritional support for patients with mild nutritional depletion.*

* *Has special application in obese patients, particularly Type II diabetes, to minimise hyperglycemia and hyperinsulinemia, mobilise fat stores and enhance ketone bodies synthesis and at the same time sparing body protein.*

* *However, due to the expenses and lack of proven efficacy, it is diffcult to support routine administration of such solutions to the well-nourished, uncomplicated post-operative patients.*

Regime : standard crystalline amino-acid solutions at 1 - 1.5g protein/ kg without supplemented fat or dextrose.

Complications of Parental Nutrition

PERIPHERAL TPN :

1. Local	*2. Systemic*
Pain	Microparticle Embolization
Extravasation	Septicaemia
Infection	Catheter tip embolization
Infusion Phlebitis	

CENTRAL LINE TPN :

1. Catheter-related

* CATHETER SEPSIS 10%

Pneumo thorax

Thrombophlebitis

Laceration of major vessels

Brachial plexus injury

Others - Air embolism

Thoracic duct injury

Pericardial tamponade

Cardiac arrythmias

Cardiac perforation

Hepatic vein thrombosis

Venous thrombo-embolism

2. Metabolic

A. Hyperosmolality problems

- may lead to hyperosmolar non-ketotic coma from osmotic diuresis from severe glycosuria.

B. Uraemia

- especially in patients with hepatic and renal dysfuntion; the protein should be restricted

C. Electrolyte Imbalance (from inadequate administration)

- hypophosphataemia can lead to 2,3 DPG deficiency resulting in reduced oxygen delivery to tissue, haemolysis, rhabdomyolysis.

- hypocalcaemia

D. Trace Elements Deficiency

a. Zinc : acrodermatitis, poor wound healing, hair loss, diarrhoea

b. Copper : leucopenia with lymphocytosis, anaemia

c. Chromium : hyperglycaemia, peripheral neuropathy

d. Selenium : cardiomyopathy

E. Essential Fatty Acid Deficiency

- dermatitis, hair loss, diarrhoea, thrombocytopenia, poor wound healing

F. Vitamin Deficiency

SPECIAL CONSIDERATION

1. Liver disease

   - in hepatic failure, the ratio of aromatic to branched-chain amino acids is increased and this is believed to lead to production of false neurotransmitters, serotonin and decreased catecholamines. These contributes to hepatic encephalopathy. However, recent studies has questioned this assumption. Present recommendation is to use intravenous branched-chain amino acids if encephalopathy is induced by the standard amino acids solutions

2. Renal disease

   - decrease nitrogen intake by increasing non-protein calories : nitrogen ratio (to reduce urea formation)

   - increase lipid proportion which provides more energy per gram and so reduces water intake

3. Respiratory disease

   - increase lipid proportion because glucose is metabolised to water and carbon dioxide and can worsen hypercapnia; however circulatory lipid can directly or indirectly induce pulmonary damage and red cell membrane oxygen diffusion. Hypoxaemia may worsen in patients with Adult Respiratory Distress Syndrome. This is believed to be due to production of metabolites that reverses pulmonary arterial vasoconstriction that shunts blood away from the unventilated segments.

MONITORING OF NUTRITIONAL IMPROVEMENT

1. Daily weighing

2. Nitrogen balance studies - once a week

$$\text{N Balance (g)} = \frac{\text{protein intake (g)}}{6.25} - \text{24h urinary urea N (g)} + 4$$

3. Return of delayed hypersensitivity skin testing.
4. Return of serum albumin and transferring to normal levels takes time and hence not a good guide.

RECOMMENDED READINGS

Pestana C (1989) : *Fluids and Electrolytes in the Surgical Patient,* 2nd edition. Williams and Wilkins, Baltimore

Saunders C, Nishikawo, Wolfe B (1993) : *Surgical Nutrition - a Review.* J RCSEd Vol 38 No 4 : 195 - 204.

ONCOLOGY

5.1 Principles of Oncological Management
5.2 Role of Surgery in Cancer Management
5.3 Hormonal Therapy in Cancer Management
5.4 Radiotherapy
5.5 Cancer Chemotherapy
5.6 Principles of Cancer Screening
5.7 Breast Cancer Screening
5.8 Colorectal Cancer Screening

5.1 PRINCIPLES OF ONCOLOGY MANAGEMENT

Primary Prevention (Control of Environmental Risk Factors)

1. Health Education (dietary and personal habits, etc)
2. Control of Occupational Carcinogens

Secondary Prevention (Screening)

The aim is to detect premalignant lesions and early cancers

1. Mass Screening
2. Risk Group Screening

Cancer Control

The aim is to achieve cure; and if this is not possible, then a long recurrence-free interval

1. Locoregional Control -

   surgery

   radiation therapy

   chemotherapy

   hormonal therapy

   combination therapy

   immunotherapy

2. Systemic Control -

chemotherapy

hormonal therapy

immunotherapy

Palliative Care

The aim is to improve the quality of life before the patient succumbs to the cancer; hence the life expectancy and the post-therapy morbidity must be taken into account before recommending any major therapeutic options. The main concern in palliative care would be pain relief.

1. Pain and its management
2. Management of complications eg. intestinal obstruction, spinal cord compression, pathological fractures, etc.

Prophylaxis

1. Chemoprophylaxis

tamoxifen for breast cancer

vit C for colonic cancer

vit A for upper aerodigestive tract

* *not proven effective*

2. Surgical prophylaxis

total colectomy for familial polyposis

subcutaneous mastectomy for severe dysplasia in women with family history of breast cancer or cancer in the contralateral breast

3. Immunoprophylaxis

   hepatitis B immunisation for hepatoma

Rehabilitation

1. Speech therapy for laryngectomate
2. Stoma care for stomates
3. Counselling after mastectomy

CURRENT APPROACH IN CANCER MANAGEMENT

A. Integrated Management Team (Oncology Team)

Primary Care Team - surgeon

radiotherapist

oncologist

family physician

pain clinic

Supportive Care - psychiatrist

counsellors, social workers

social support group

spiritual leaders

B. Hospice Care Concept

Home Nursing -

visit by volunteers from the medical profession to provide care in a familiar, loving, homely environment.

Institutionalised Care -

in terminal stage where family is unable to cope.

5.2 ROLE OF SURGERY IN CANCER MANAGEMENT

Surgery is the oldest form of treatment for cancer, and has retained its leading role for centuries, and is still the treatment of choice in a high percentage of cases.

Diagnostic Surgery

biopsy : incisional

excisional

tru-cut

* **while it is not possible to have a pre-operative histological diagnosis all the time, it must be stressed that no radical or mutilating surgery should be performed before a histological confirmation; frozen section if necessary.**

Staging

Hodgkin's lymphoma

axillary clearance for carcinoma breast

supraomohyoid neck dissection for head and neck cancer

* **purpose is to guide treatment and to predict prognosis.**

Curative Surgery

1. wide excision, en-bloc excision
2. debulking of residual disease (eg. ovarian Ca)
3. resection of metastatic disease (eg. hepatic or pulmonary secondaries from colon, kidney)

- basic aim is to remove entire tumour, with a clear margin of at least 5 cm, and in continuity the immediate neighbouring structures and lymphatics.
- achievable in early disease and occasionally in advanced disease.
- 2 important criteria before curative surgery performed :
  a. technically possible to remove primary tumour with a reasonable margin of healthy tissue.
  b. absence of metastases (with some notable exceptions eg. colonic carcinoma)
- contra-indications to curative surgery :
  a. if operative mortality too high in relation to chance of cure (eg. some pancreatic cancers).
  b. if mutilation is too disfiguring
  c. if there is a risk of inducing deterioration in the course of the disease.
  d. if similar results can be obtained by conservative and non-surgical treatments.

Palliative Surgery

1. internal fixation for bone metastases
2. pain management
3. anticipated intestinal obstruction
4. toilet procedures

- aims of palliative surgery are :
  a. elimination of troublesome symptoms eg. obstructive jaundice, dysphagia.
  b. prevention of complications eg. bleeding
  c. improve quality of life
  d. psychologic uplift.
- no attempts to cure and hence operative risks must be carefully weighed against benefits.

Vascular Access

1. regional isolation perfusion (eg. isolated perfusion for malignant melanoma, chemo-embolisation in liver carcinoma)
2. long-term implantable catheter and pump
   eg. Porta-cath, Hickman's catheter

- cannulate artery for regional perfusion of chemotherapeutic drugs; reduce systemic toxicity.
- Porta-cath allows for 1,000 injections and hence reliable and long-term venous access.

Oncologic Emergency Surgery

1. cord compression
2. intestinal obstruction
3. haemorrhage
4. perforation
5. respiratory embarrassment
6. cardiac tamponade

- may be the terminal event and hence much deliberation needed before considering surgery eg. ruptured hepatoma.
- simple life-saving procedures; no place for heroic surgery.

Hormonal Manipulation

1. oophorectomy
2. orchidectomy
3. adrenalectomy

Reconstructive Surgery

1. breast reconstruction
2. testicular prostheses

Surgery for Pain

surgical disruption of pain pathways

* cordotomy (spinothalamic tractotomy)

* rhizotomy

* thalamotomy

- **if life expectancy is less than 3 months, it is best to avoid surgical procedures for pain relief.**

- **these neurosurgical procedures carry associated complications eg. urinary retention.**

Prophylactic Surgery

1. total colectomy for polyposis coli and long-standing ulcerative colitis with dysplastic changes

2. subcutaneous mastectomy for severe dysplasia in fibrocystic disease of the breast

5.3 HORMONAL THERAPY IN CANCER MANAGEMENT

Cancer Control

1. Hormones

   * progesterone in renal cell carcinoma

   * thyroxine in thyroid cancers

   * steroids in leukaemia, myelomas and advanced breast carcinoma

   * oestrogens in prostate carcinoma

   * androgens in breast carcinoma

2. Hormone Antagonist

   * tamoxifen for carcinoma breast

   * cyproterone acetate for carcinoma prostate

3. Endocrine Ablation

   * surgical : orchidectomy

   * radiation : radiation oopoherectomy

   * pharmacological : aminoglutethimide for adrenal suppression, LHRH agonist for androgensuppression

Hormonal therapy, unlike chemotherapy, is NEVER curative; resistant tumour cells will arise. It is likely that there are both hormone-sensitive and hormone-resistant population as has been demonstrated in prostatic carcinoma.

Management of Complications

1. Steroids for hypercalcaemia, reduction of intracranial pressure in brain secondaries and suppression of bone marrow in polycythaemia rubra vera

2. Calcitonin to reduce osteolysis in bony metastases

RECOMMENDED READING

Forrest APM (1989) : *Tamoxifes comes of age.* Br J Surg, 76 : 325-6

5.4 RADIOTHERAPY

Mode of Action

1. DIRECT ACTION - Primary ionisation of molecular structures.
2. INDIRECT ACTION - Reactive products from hydrolysis of water which secondarily ionise biological targets.

Hence can be sensitised by :
- *increasing intrinsic sensitivity of target eg. hyperthermia*
- *increasing reactivity of radiolysis products eg. oxygenation by hyperbaric treatment*

Types of Radiotherapy :

1. External Beam Radiotherapy

   β Rays

   Superficial XRays (60kV)

   Deep XRays (250 kV)

   Supervoltage (1 MeV - 30 Mev)

2. Brachytherapy

   intracavitary eg. carcinoma cervix

   interstitial eg. carcinoma tongue

   mould

   * **Caesium, indium or radium as radioactive source**

3. Unseal isotopes - I131, phosphorus

Intent of Radiotherapy :

1. Radical

A. PRIMARY ELECTIVE MANAGEMENT -

may be preferred mode of treatment because :

- preserve form and function
- high operative morbidity and mortality eg. Ca bladder, posterior 1/3 tongue
- medically unfit
- refusal to consent for surgery
- unresectable because of local extension eg. Ca prostate

B. PRIMARY COMBINED MANAGEMENT

i) Adjuvant to Surgery

- pre-, intra-, post-operative or sandwich
- useful in loco-regional control

* *pre-operative radiotherapy are given for :*

downstaging tumour for resection eg. carcinoma rectum

sterilise operative field to reduce dissemination

reduce bleeding to facilitate dissection eg. glomus tumour

* *if low dose pre-operative radiation given, surgery can be performed with minimal delay*

* *if high dose pre-operative radiation given, a six weeks' delay is required to allow the tissue reactions to settle*

* *intra-operative radiotherapy allows for more localised and accurate radiation therapy, but require specialised setup allowing transfer between operating theatre and radiotherapy units*

* *postoperative adjuvant radiotherapy kills all residual tumour cells and is usually performed 4 - 6 weeks after surgery. It is applicable only if residual tumour are thought to have been left behind eg. unclear resection margins, positive lymphatic spread or spillage*

* *sandwich technique involves having pre-operative radiotherapy and post-operative radiotherapy*

ii. *Adjuvant to Chemotherapy*

- testicular and intracranial deposits of leukaemia
- large lymphomatous deposits after chemo in lymphoma

C. *SECONDARY MANAGEMENT*

Local recurrence eg. carcinoma breast

Lymphatic recurrence eg. breast and rectal carcinoma

2. Palliative

Short treatment course without much additional discomfort or complications. The aim is to prolong a useful and comfortable life.

* pain relief (bone, liver secondaries)
* control of haemorrhage (bladder, renal cell carcinoma)
* relief of obstruction (prostate carcinoma, pancoast tumour)
* relief of neurological complications (spinal metastases)
* suppression of effusion

* healing of ulceration (breast carcinoma)
* suppression of distressing symptoms (rectal carcinoma)
* prophylactic (bone secondaries with impending fracture)
* "growth restraint" of aggressive tumour
* control of systemic effects eg. paraneoplastic syndromes with irradiation of primary tumour

3. Management of Benign Lesions
   - I^{131} for functioning thyroid adenoma and primary thyrotoxicosis
   - pituitary adenoma
   - ankylosing spondylitis
   - keloids

Recent Advances

1. Radiosensitisers - 5FU, halogenated thymidine (chemo-radiation)
2. Neoadjuvant Chemotherapy to reduce tumour population
3. Hyperfractionation
4. Multiple fields irradiation
5. Hyperthermia
6. Hyperbaric environment

* *hyperfractionation involves dividing the radiation therapy in multiple sessions so as to allow recovery of normal tissue (usually faster than tumour tissue) as well as reoxygenation of the hypoxic portions of the tumour mass thereby increasing the susceptibility of the tumour cells to the radiation dose.*

* *multiple field irradiation keeps the tumour irradiated but distributes the unwanted radiation to overlying tissues by having different fields of penetration*

Complications :

General

1. Radiation sickness
2. Skin reaction - acute or chronic radiodermatitis
3. Induced malignancy

Strict criteria needed to prove induced malignancy :

* *documented proof of dose/fields*
* *adequate latent period*
* *tumour occurs within radiation fields*
* *unequivocal evidence that tumour is different from original growth*

Specific :

1. Head and Neck
   * mucositis, dry mouth
   * osteonecrosis
   * retinitis, optic nerve atrophy
   * myelitis, brain stem damage
2. Pulmonary
   * pneumonitis, fibrosis

* carditis, pericarditis
* oesophagitis
* myelitis

3. Gastrointestinal Tract

* acute radiation enteritis : diarrhoea
* chronic radiation enteritis : fistula
  adhesions
  stricture
  bleeding
  mal absorption

4. Bladder

* haemorrhagic cystitis
* contracted bladder

5.5 CANCER CHEMOTHERAPY

Use of Chemotherapy

1. Purpose of using chemotherapeutic agents - to prevent cancers cells from multiplying, invading, metastasizing and killing the host.

2. Exerts influence by suppressing cell multiplication and tumour growth.

Different Roles of Chemotherapy

1. Curative Intent -

   to treat highly chemosensitive tumours and cure patients despite disseminated disease eg. germ cell tumour, leukaemia, lymphoma, childhood malignancies.

2. Palliation -

   use of chemotherapy to control or regress disease to relieve symptoms or prolong survival.

3. Adjuvant chemotherapy -

   to treat undetectable systemic microscopic disease following primary therapy (surgery and/or radiotherapy) to improve the likelihood of cure.

4. Neo-adjuvant chemotherapy -

   as upfront treatment to downstage the tumours before primary local therapy (sugery and/or radiotherapy).

5. Chemoprophylaxis -

   to prevent the development of cancer among those in high-risk groups.

BREAST CANCER

1. Locally Advanced Breast Cancer

- offered upfront in patients with locally advanced diseased i.e. >T3 and/or N2

- improved disease-free and overall survival in non-randomised studies

- serves as an ideal in vivo model for evaluating chemosensitivity of tumour to agents used

2. Node (+) Breast Cancer

- adjuvant chemotherapy in premenopausal women following surgery has demonstrated improved overall survival

- adjuvant tamoxifen in post-menopausal women has shown improved overall survival

3. Node (-) Breast Cancer

- adjuvant chemotherapy in premenopausal women has demonstrated improved disease-free survival. Studies not mature to comment on overall survival.-no treatment needed in post-menopausal women

4. Metastatic Breast Cancer (hormonal therapy)

- hormonal manoeuvers like tamoxifen (anti-estrogen), megestrol acetate (progesterone), halotestin (androgen), aminogluthetimide, LHRH agonists etc, useful in ER (+) PR (+) patients.

- clinical indices of likelihood that suggest hormone receptor (+) are : post-menopausal at presentation, long disease-free interval, bony, cutaneous or nodal recurrence.

- brief trial of hormones justified in most cases

5. Metastatic Breast Cancer (chemotherapy)

- systemic combination chemotherapy offers 40-60% response rates but no curative potential.
- indicated in patients with progressive, symptomatic disease
- may be offered preferentially to those with visceral involvement, eg. liver and lung, as these tend to be hormone receptor-negative.

COLO-RECTAL CANCER

1. Anal Canal Cancer

- upfront chemotherapy plus radiation produces equivalent results to abdomino-perineal resection.
- preferred therapeutic option as patient retains faecal continence.

2. Colon Cancer

- adjuvant chemotherapy with 5-FU and levamisole for node-positive colon cancer following surgery.
- disease-free survival and overall survival benefit.
- proven in initial study from NCCTG and again in confirmatory study by Intergroup Study.
- preliminary data suggests that adjuvant 5-FU/folinic acid may be as good, but results are not mature

3. Rectal Cancer

- pelvic radiotherapy improves loco-regional control of disease, but provides no overall survival advantage.
- randomised studies show improvement in disease-free and

overall survival in Duke's B2 and C rectum cancer, treated with post-operative chemotherapy plus radiation versus post-operative chemotherapy plus radiation versus post-operative radiotherapy.

- combined chemotherapy and radiation reduces locoregional and systemic recurrence.

3. Metastatic Colorectal Cancer

- treatment programs are 5-FU based.
- biochemical modulation of 5-FU with folinic acid is curent standard.
- response rates of ~ 40% with no curative potential.
- indicated in patients with progressive or symptomatic disease.

Malignant Lymphoma

- despite advanced disease, combination chemotherapy is potentially curative for patients with intermediate- and high-grade lymphoma.
- a wait-and-watch approach may be adopted for patients with advance stage low-grade lymphoma.
- early stage disease may be treated with radiotherapy, chemotherapy, or combined modality.

Urogenital Cancer

1. Germ Cell Tumour - gonadal

- early stage seminoma is treated with surgery with or without radiotherapy.

- seminoma is extremely chemosensitive with reported continuous disease-free survival ranging from 60 to 92% among patients with advanced disease.

- stage I non-seminomatous testicular cancer can be treated by wait- and - watch approach (weekly monitoring of AFP for 6 weeks) or early chemotherapy, with > 90% cure rate.

- systemic chemotherapy cures 80% of patients with disseminated non-seminomatous testicular cancer.

2. Germ Cell Tumour - extragonadal

- front-line cisplatin-based chemotherapy is curative in most patients with extragonadal seminoma.

- 50% of patients with non-seminomatous extragonadal germ cell tumours are cured with chemotherapy.

3. Node (+) Bladder Cancer

- suggestion from 3 randomised trials that adjuvant chemotherapy following surgery improves disease-free survival.

4. Locally Advanced Bladder Cancer

- neoadjuvant chemotherapy has been investigated with an aim for bladder preservation and survival improvement.

5. Metastatic Bladder Cancer

- response to standard combination chemotherapy is 70%.

- complete response achieved in 36% (11% requiring surgical resection of residual disease).

- small subgroup of patients maintain long disease-free interval.

6. Renal Cell Cancer

- not chemosensitive

- immunotherapy gives higher response rate (15% to 25%)

ovarian cancer

- response to cisplatin-based combination chemotherapy ranges from 70% to 80% in advanced ovarian carcinoma.

- systemic cisplatin-based chemotherapy after optimal surgical debulking results in long-term disease free survival in 12% of patients with stage III ovarian carcinoma.

- in stage II and poorly differentiated stage I tumours, adjuvant chemotherapy improves disease-free survival when compared with historical controls.

7. Cervical Carcinoma

- response of locally advanced disease to neoadjuvant cisplatin-based combination chemotherapy ranges from 70% to 90% (CR as high as 35% has been quoted).

- neoadjuvant chemotherapy facilitates surgical resection.

- most studies report reduced incidence of positive pelvic and paraaortic lymph nodes in treated patients.

- two trials (one randomised and one unrandomised) on neoadjuvant chemotherapy followed by surgical resection reported improved disease-free survival and overall survival in stage IB to IIB disease.

- chemotherapy followed by radiotherapy does not appear to have impact on survival in stage III and IV patients.

- unrandomised studies on concomitant chemoradiation suggest improved pelvic control and survivals.

LUNG CANCER

1. Small Cell Lung Cancer

- chemotherapy offers improved survival in patients with limited or extensive stage disease.
- potentially curative in 10 - 20% of patient with limited stage small cell lung cancer.

2. Non-Small Cell Lung Cancer

- no proven benefit in post-operative setting, as adjuvant therapy
- palliative chemotherapy for those with symptomatic metastatic disease with response rates ~ 30%.
- randomised studies show improved survival in patients treated with concomitant chemotherapy and radiotherapy for inoperable stage III disease.
- neoadjuvant chemotherapy appears promising in increasing the rate of complete resection in patients with locally advanced lung cancer.

HEAD AND NECK CANCER

1. Squamous Cell Cancers

- chemoprophylaxis with 13-cisRetinoic acid has been shown to reduce the risk of second primary in patients with treated SCC of head and neck.
- response rates with cisplatin-based regimens.

2. Nasopharyngeal Cancer

- highly chemonsensitive malignancy.
- response rates of ~ 70% seen in metastatic disease.

- potential role of chemotherapy in neoadjuvant and adjuvant setting is not well studied.

5.6 CANCER SCREENING

Principles

1. High incidence of disease in the population with serious consequences.
2. Natural history of the disease is well-understood and there should be an early preclinical phase which can be detected by a suitable test.
3. Detection and treatment of the disease at the asymptomatic stage should produce significant benefit.
4. There should be a suitable method for detecting the disease and the method should be

    * simple with high sensitivity, specificity and reproducibility.

    * acceptable to population.

    * cost effective.

    * not hazardous to screened population.

- WHO, 1968

Problems of a Screening Programme

1. Logistics
2. Population compliance
3. Formulation of screening schedule
4. Adverse effects

    - radiation risk from radiological screening.

    - pyschological morbidity from false-positives and the risk of false-negatives.

- physical morbidity from invasive screening methods.

- unnecessary surgical procedures from over-diagnosis (false-positives)

5. Assessment and application of new screening methods

6. Cost

Evaluation of Screening Programmes

Assessment Criteria :

* increased detection of early stage disease

* prolonged survival time

* mortality of screened population should be lower than non-screened population

Prolonged survival time can be due to :

LEAD TIME BIAS - the duration of survival is prolonged only because of earlier detection. The time of death remains the same.

LENGTH BIAS - increased detection of slow-growing tumors which may not be clinically significant. Mortality from aggressive tumours remains unchanged.

SELECTION BIAS - the population coming forward for screening may not be representative of the general population just as a hospital population is not representative of the general population.

Best way to evaluate any screening programme is to have a randomised controlled trial of whole population invited for screening and a controlled non-screened population. A comparison of the total incidence and mortality of the disease in these population should include non-attenders as well as cancers not detected by the screening programme in the screened populations,

in order to eliminate the length and selection bias. Whole populations should be studied since it is the result of the screening programme on the population as a whole that matters.

Accepted General Screening Programmes :

A. Breast Cancer

B. Cervical Cancer

Cancer Screening In Selected Populations :

1. Hepatocellular carcinoma among hepatitis B carriers
   - α FP or ultrasonic examination
   - In S E Asia, Taiwan
2. Gastric carcinoma in Japan
   - gastroscopy
   - double contrast Ba meal
3. Oesophagus carcinoma in China
   - balloon cytology
4. Nasopharyngeal carcinoma in China and Hong Kong
   - Epstein Barr Virus serology
5. Malignant melanoma in Australia
   - clincial examination along the beach

RECOMMENDED READING

Sweetland HM, Monypenny IJ (1993) : *Cancer Screening - with special reference to breast cancer.* Surgery Vol 21 : 337 - 40. The Medicine Group, Oxon UK.

5.7 BREAST CANCER SCREENING

Why Screen

1. High prevalence (26.5 per 100,000 women per year and rising in Singapore)

2. If lump less than 1 cm in diameter, probably no metastasis has occurred, hence cure achievable.

Screening Methods

1. Breast self-examination - not proven useful

2. Annual medical checkup (well-women clinic)

3. Mammography : single oblique view

   2 views (AP and Lateral)

Clinical Trial Reports

* NYHIP Study (Shapiro, 1963) - by 10 years about 30% fewer breast cancer deaths in screened group, 23% after 18 years.

* BCDDP Study (National Cancer Institute and American Cancer Society) - substantial following large shift towards a high proportion of cancers being diagnosed and treated in a more favourable stage even after allowing one year's lead time in detection of cases through screening.

* Nijmeger Project (Netherlands) - reduction in breast cancer mortality of about 50% attributable to periodic screening with mammography for women more than 50 years old.

* National Breast Screening Study (Canada) - among women more than 50 years old when first screened, a consistent picture is seen in

that a reduction in breast cancer mortality emerges 3-4 years after screening started.

PROGRAMME RECOMMENDED

General Population Screening

-NHS Breast Screening Programme, UK (based on Forrest Commission Recommendations)

All females between 50 and 64 years old

Method - single oblique-view mammography

Frequency - once every 3 years

Risk Groups Screening

1. High Risks :
   1. previous carcinoma in one breast
   2. strong family history
   3. presence of premalignant diseases eg. papillomatosis

Programme - annual mammogram irregardless of age.

2. Intermediate Risks :
   1. extensive cystic mastitis especially where biopsy indicates significant hyperplasia
   2. family history in distant relatives

Programme - baseline mammogram, then 3 yearly until 50, then annual mammography.

DIAGNOSTIC FEATURES OF MAMMOGRAPHY :

* Mass with irregular borders and extension into adjacent parenchyma.
* Skin thickening and loss of definition of subcutaneous fat layer.
* Skin retraction and/or dimpling.
* Stippled punctate calcifications within a mass or even in the absence of a mass.
* Venous engorgement.

Risk of breast cancer on basis of parenchymal patterns as classified by Wolfe's classification is a highly controversial issue.

SET-UP OF A BREAST SCREENING PROGRAMME

Breast screening is community-based and not a hospital-based pursuit

Basic Screen

Aim : to detect mammographic abnormalities, not clinical disease.

Personnel involved - radiographer, radiologist

community outpatient services

mobile van to outlying areas

Assessment of Screen-Detected Abnormalities

Aim : to ascertain whether biopsy is necessary

Methods : additional mammographic views

physical examination

ultrasound

Personnel involved - hospital- based personnels required

* radiologist

* surgeon

* cytologist

(may or may not require hospital facilities. Can be based in a well-equipped community outpatient service)

Biopsy

1. Palpable mass - (fine needle aspiration cytology)

Tru-cut biopsy

Excision biopsy

2. Impalpable mass - mammographic localisation biopsy

stereotactic FNAC

(hospital facilities required)

RESULTS OF UK BREAST SCREENING PROGRAMME

- annual clinical examination and biannual mammography over 7 years

First round screening :

0.5% will have diagnosable cancer

10% will have suspicious mammographic findings

0 - 20% of cancers diagnosed on mammography are likely to be in-situ changes

Overall expectation :

8% of all breast cancer deaths prevented

1 in 1,500 women screened has life expectancy prolonged

Cost of 39,000 pounds per life saved

COMPARED TO CONTROL POPULATION, THE REDUCTION IN BREAST CANCER MORTALITY OF 14% WAS NOT STATISTICALLY SIGNIFICANT

RECOMMENDED READING

Forrest APM (1989) : *The Surgeon's Role in Breast Screening.* World J Surg, 13 : 19-24.

Eddy DM (1989) : *Screening for Breast Cancer.* Annuals of Int Med, VIII N5 : 389-98.

Witcombe JB (1990) : *Dangers of Nationwide Breast Screening.* Hospital Update, Mar 1990 : 185-6.

5.8 SCREENING FOR COLORECTAL CANCER

Basis

1. Majority arise from adenomatous polyps (polyp to cancer sequence)
2. Survival rates correlate to Duke's staging
3. Second commonest cancer among men

Screening Methods

1. BOWEL SYMPTOMS QUESTIONAIRE

- high positive rate with low predictive value
- generally unpopular

2. ENDOSCOPY

* *rigid/flexible sigmoidoscopy*
* *colonscopy*

- high specificity and sensitivity
- polyps found can be removed at the time of screening (screening as well as therapeutic in one session)
- time consuming
- associated with high screening risk (1% perforation rate for elective colonoscopy)
- suitable for high-risk group screening or those tested positive for occult blood in stools i.e. second-tier screening

- unpopular with population (low compliance)

3. FAECAL OCCULT BLOOD TESTING

- accepted standard is guaiac-impregnated paper (haemoccult)
- most widely used
- low specificity and sensitivity
- newer immunological tests recently available
- require pre-test 3 days of non-meat diet and 3 consecutive tests
- results affected by drugs eg. vitamin C, oral iron preparation

TRIAL RESULTS

Nottingham Study (mean follow-up 3 years, compliance 53%)

- *cancer detection rate : 2 in 1000 screened*
- *screened cancer usually well-differentiated (78% vs 45%)*
- *tumour size and fixity more favourable in screen- detected cancers*
- *lower presenting Duke's stage*
- *no mention of influence on mortality rates*

Memorial Sloan-Kettering Cancer Centre, New York, USA

- *sensitivity 70%*
- *cancer detection rate : 3 in 1000 screened*
- *screened cancer of early stage (59% vs 33%)*
- *10 years follow-up : no difference in overall mortality rate 43% decrease in cancer-specific mortality rate in screened population (not statistically significant)*

EVIDENCE TO DATE : no direct evidence that Haemoccult screening is effective.

SCREENING PROGRAMME

Risk Groups Screening

Patient Group and Risk	Surveillance Program*
Markedly increased risk	
Familial polyposis coli and associated syndromes	FS every 6-12 mo from teens to age 40 y; colectomy if multiple polyps found
Cancer family syndrome	Annual FOBT and colonoscopy every 2-3 y, beginning at 20 y
Universal ulcerative colitis for 8 - 10 y	Annual colonoscopy with multiple biopsies; colectomy if severe dysplasia is found and confirmed
Moderately increased risk	
Previous colon cancer or previous adenoma(s)	Colonoscopy 1 y after resection and then every 3 y if findings are normal; annual FOBT
Left-sided ulcerative colitis for 15-20 y	Colonoscopy every 1-2 y with multiple biopsies; colectomy if severe dysplasia found and confirmed
First-degree relative (s) with history of colon cancer	Annual BOBT and FS every 3-5 y beginning at age 35-40 y; if >2 relatives, colonoscopy every 3-5 y
Women undergoing irradiation for gynaecologic cancer	Annual FOBT and FS every 3 y after diagnosis and radiation therapy
Probable increased risk	
Previous gynaecologic or breast cancer, or ureterosigmoidoscopy	usual screening test of rectal examination and FOBT and FS every 3-5 y after diagnosis of underlying associated disease
Other gastrointestinal tract polyposis syndromes	Periodic examinations of upper and/or lower gastrointestinal tract, depending on cancer risk in specific syndrome

* FS indicates flexible sigmoidoscopy, either 60 cm or 35 cm, which is preferred to rigid sigmoidoscopy; and FOBT, fecal occult blood test.
* Colonoscopy refers to total colonoscopy to the caecum; in some cases double-contrast barium enema examination plus flexible sigmoidoscopy may be substituted.

- American Gastroenterological Association

General Population Screening :

Age : from 50 years old.

Frequency : annual flexible sigmoidoscopy for 2 years, then once every 3-5 years.

GENERAL TOPICS IN SURGERY

6.1.	Ulcer Management
6.2	Investigation of an Outbreak of Wound Infection
6.3	Surgical Drains
6.4	Hospital Discipline with Viral Infective Patients
6.5	Hazards in Operating Theatres
6.6	Lasers in Surgery
6.7	Monoclonal Antibodies in Surgery
6.8	Tumour Markers
6.9	Imaging in Surgery
6.10	Ambulatory Surgery
6.11	Surgical Audit 267
6.12	Principles of Fracture Management
6.13	Factors to Consider when Setting up Operating Theatres
6.14	Antibiotics in Surgical Practice
6.15	Assessment of Organ Function
6.16	Terminology in Transplant Surgery
6.17	Haemostasis in Surgery
6.18	Minimal Access Surgery

6.1 ULCER MANAGEMENT

A. Determine Nature of Ulcer

Malignant	- Primary :	Squamous cell carcinoma
		Basal cell carcinoma
		Kaposi sarcoma
		Malignant melanoma
		Cutaneous lymphoma
	- Secondary :	Breast carcinoma
		Lung carcinoma
		Gut carcinoma
Benign -	Traumatic	
	Venous (Gravitational)	
	Arterial (Ischaemic)	
	Infective	
	Pressure ulcers (Neurogenic)	

B. Local Management of Ulcer

1. Wound Cleansing

Superficial ulcer	- irrigation with saline/clean water
Dirty, infected, slough	- antiseptic solution eg. aqueous chlorhexidine 0.05%, povidone-iodine

Associated eczema - potassium permanganate 0.01%

Gritty wounds - hydrogen peroxide 3%

2. Dressing

Occlusive

- for excluding exogenous bacteria from ulcer; however endogenous skin pathogens not affected

Simple dressing

- low adherent dressing (eg. Melolin)

- paraffin gauze; those impregnated with antibiotics are not recommended

Semi-permeable adhesive films

- allow gases and water vapour to pass through but not bacteria and wound exudate (Opsite, Tegaderm)

Hydrogels and Hydrocolloids

- contain starch polymer (hydrogels) and hydrocolloid matrix to absorb exudates. Hydrocolloid also promotes growth of granulation tissue and epithelisation. Come in the forms of water, paste or powder.

Capillary and Osmotic Absorbents

- debrisan consist of beads of starch polymer (dextranomer) which removes bacteria and exudate; applied to wound over a plain gauze and covered with a secondary dressing. May need replacement twice daily. Also comes as a paste or absorbent pad.

- iodosorb contains modified starch gel with iodine

Foam Dressing

- natural material eg. sorbsan/kaltostat made from seaweed. When in contact with exudating wound, calcium-sodium exchange occur in the alginate fibre to form a fibrinous gel creating a moist, warm healing environment. Cannot be used on dry or minimally exudating wounds.

- synthetic foam dressing (Lyofoam) consisting of inner hydrophilic absorbent layer and outer hydrophobic protective layer. Can be left in-situ in a moist wound upto 7 days.

- synthetic foam (Silastic foam) is formed before use by using silicone base with stannous octoate catalyst. Can be fashioned into bung to fit the deep wound or cavity.

3. Debridement

Necrotic tissues should be removed surgically

Superficial slough may be removed by washing

Thick, yellow slough can be removed by saline irrigation under pressure

4. Antibiotics

No place for topical antibiotics

Indicated when there is evidence of infection; bacterial colonisation does not delay wound healing and systemic antibiotics in such instances do not hasten healing

C. Management of Underlying / Associated Conditions

Correction of malnutrition, anaemia

Control of metabolic diseases eg. diabetes mellitus

Control of cardiovascular diseases eg. congestive cardiac failure

Relieve pressure points

Relieve venous hypertension

Improvement of circulation eg. femoro-popliteal bypass.

IDEAL DRESSING

1. Satisfy These Functions

Protects wound

Keeps wound moist

Assist removal of exudate and slough

Encourage healing

Reduces likelihood of infection

2. Satisfy These Conditions

Does not contain cytotoxic material

Not irritant or allergenic

Easy to apply, comfortable and non-adherent

Widely available and inexpensive

SKIN COVER

The best form of dressing is skin.

Skin cover can be achieved by

direct approximation

flaps - local, regional, distant

grafts - vascularised, non-vascularised

Recent advances - skin culture, skin dressings

Conditions to consider befor deciding skin cover :

fit patient with malnutrition corrected

all medical conditions optimised

wound covered with healthy granulating tissue

recipient site should have $< 10^5$ organism/g tissue

Direct Approximation

1. Edges are brought together with undermining of the underlying tissues.
2. Contraindicated if tension occurs or distortion of anatomic landmarks

Flaps

1. Local Flaps - advancement flaps

   transposition flaps (nasolabial)

   rotation flaps

   Z plasty

2. Regional Flaps - cutaneous, fasciocutaneous (dorsalis pedis)

myocutaneous (pect major, lat dorsi)

osteomyocutaneous (spine of scapula)

3. Distant Flaps - eg. from abdominal wall to hand with severance of the flap from the parent tissue when vascularisation has matured with the recipient site or via a carrier eg. abdominal flap to arm and then to face

4. Free Flaps - involves vascular anastomosis

- *random flaps are those whose blood supply comes from the subdermal or reticular plexus; so the length to breath ratio is important to ensure survival of flap*

- *axial flap has a direct cutaneous artery while myocutaneous flaps has a vascular pedicle with perforating vessels supplying the overlying tissue so that the whole unit can be transferred*

- *free flap involves dividing the vascular pedicle and re-anastomosing it to a vessel on the recipient site; this way distal flaps can be utilised eg. radial forearm flap*

Skin Grafts

1. Split skin graft

2. Full thickness graft

3. Composite graft

4. Mesh graft

5. Patch graft

- the thinner the graft, the better the survival of the graft and epithelisation of the donor site; however graft contracture may occur

- full thickness graft,which includes taking the dermis, has minimal contraction and gives better colour, texture and hair; however size of graft is limited and healing of donor site may need a split skin graft since no skin appendages are left in the donor site
- composite graft includes taking the underlying supportive tissue and hence is limited by its size; flaps will be preferred
- mesh graft involves expanding the skin graft to 6X its size and laying them on a mesh before applying to the donor site; allow grafting of large defects and escape of exudates. However coverage of the donor site is poor and mesh graft contracts more than split skin graft
- patch graft involves applying bites of skin grafts on the donor site like pasting postage stamps
- Lawson's conditions for graft survival :
  a. graft should be applied to healthy granulating surface
  b. only skin should be transplanted, care should be taken to exclude adherent fat
  c. graft should be accurately and firmly applied to the granulating surface
  d. the new skin should be kept in its new position without interruption, and that it should be lightly covered with a layer of lint, and over this a small compress of cotton wool

6.2 INVESTIGATION OF AN OUTBREAK OF WOUND INFECTION

SEQUENCE OF ACTIVITIES

1. Outbreak noted by infectious control team during routine surveillance
2. Identification of organisms
3. Identify common factor
4. Review surgical discipline
5. Investigate for any breach in asepsis discipline
6. Containment of Outbreak
7. In-house education and surveillance

Identification Of Organism

- culture of wound
- phage typing organisms isolated

Identification Of Common Factor And Culturing Of Personnels

- ward
- operating theatre
- surgical team (doctors and nursing staff)

Investigation Of Breach In Surgical Discipline

- adequacy of pre-operative preparation
- operating theatre discipline
- surgical techniques
- post-op wound care : changing of dressings
  frequency of wound inspection

Investigation Of Break In Asepsis

- culture from : operating theatre air
  water used by operating team
  all water sources
  ventilation and filters

Containment Of Outbreak

- isolation ward for affected patients
- barrier nursing
- treatment of identified carriers eg. chlorhexidine cream for posterior nares of staphylococcus aureus carriers
- change of vocation for persistent carriers
- closure of involved operating theatres
- correction of breach in asepsis discipline

Prevention And Early Detection

- in-house training programme for all health personnel

- formation of infection control team / committee which should include a bacteriologist, nursing staff, surgeon and a specialist in infectious control

- routine surveillance and analysis of infection rates and type of organisms in the respective surgical specialities

6.3 SURGICAL DRAINS

Clinical Application

1. Postoperative Drainage

- of infective focus
- to drain normal body fluid that cannot be handled by the body eg. after extensive dissection
- to collapse dead space; essential for healing eg. myocutaneous flaps in head and neck surgery, skin flaps after mastectomy
- to detect anastomotic leak/bleeding
- to assist re-expansion of lungs after pulmonary lobectomy
- to aid healing eg. bladder surgery, urethral repair, oesophageal surgery

2. Therapeutic Drainage Of

- pneumo-, haemo-, pyo- thorax
- intestinal obstruction or ileus
- percutaneous drainage of deep abscesses
- acute retention of urine

3. Prophylactic Drainage

- chest tube for patients with fractured ribs requiring assisted ventilation
- caecostomy tube after colonic resection
- nasogastric suction for anticipated postoperative ileus

Types of Abdominal Drains

1. Close Drains
   A. Drainage by gravity eg. tube drains
   B. Drainage by suction eg. radivac drains
2. Open Drains
   A. Gauze
   B. Rubber eg. corrugated drains
   C. Latex eg. penrose drains

* *Works by capillary action*

3. Sump Drain

   Has 2 lumens, one opened to the atmosphere so that perforations in the other lumen will not be blocked by tissues. Ingress of bacteria is prevented by a filter in the lumen communicating with the exterior.

Choosing a Drain

An ideal drain should be

1. soft so that it will not erode tissues
2. closed to prevent ingress of bacteria
3. made of material that will not disintegrate and leave fragments as foreign bodies

* *Rubber drains have been used since early days*

* *Silastic and PVC drains are inert and does not form tracks*

* *Silastic drains are softer and tears easily*

When a track is desirable - use rubber

Long-term drainage - use silastic drains

Precautions When Using Drains

1. Drains are 2-way conduits, draining fluid as well as allowing entry of bacteria. Weigh benefits against possible infection before deciding on drains, and then keep drains only as long as is necessary
2. Should never be brought out through the incision wound
3. Should never be brought across a joint or tendon sheath or areas where subsequent fibrosis will impair function
4. Should not be placed across a gut anastomosis because this may increase leak rate
5. A drain should not be too hard or stiff to prevent erosion into surrounding tissues especially near large vessels or solid organ
6. Drains requiring gravity for drainage should be placed at a dependent site

Duration of Drainage

1. Drains should be removed as soon as drainage subsided; usually when less than 20 mls per day
2. When the aim is to encourage apposition of surfaces, removal should be done by 48-72 hours postop when the proliferative phase of healing starts

Hazards of Drains

1. Sepsis
2. Erosion into adjacent tissues
3. Anastomotic leak
4. Knotting of drains
5. Incisional hernia at drain site
6. Slippage of drains into peritoneal cavity

6.4 HOSPITAL DISCIPLINE WITH VIRAL INFECTIVE PATIENTS (HEPATITIS, AIDS)

Transmission of virus particles can occur VIA :

1. *direct percutaneous innoculation.*
2. *spillage of blood on skin with micro-abrasions.*
3. *contamination of mucosal surfaces by infected blood.*
4. *transfer of infective agents by fomites.*

Identification Of Patient's Infectivity

* serological testing
* identification labels should be prominently displayed

Special Arrangement For Admission And Ward Care

1. isolated single room with en-suite toilet facilities
2. barrier nursing
3. room cleaning with daily floor mopping and damp dusting with hypochlorite

Treatment Of Disposable Items And Clinical Waste

1. soft disposables - double bagged with identification warning

   - incineration

2. needles - impervious container of metal or thick plastic

Treatment of Non-Disposable Equipment

* sterilisation by heat (preferable).
* chemical disinfection by soaking for at least 1 hour with 2% glutaraldehyde or 10% formaldehyde solution.
* separate set of equipment specially set aside for such patients.

Theatre Discipline

1. disposable plastic aprons beneath disposable gowns
2. double gloves
3. eye goggles
4. controlled movement of personnels into theatre room
5. no transfer of theatre equipment into common area without proper protective coverings
6. special care to prevent accidental injuries, blood spurting and spillage
7. all external surfaces of equipment, trolleys within theatre and floor wiped with chloros or glutaraldehyde at end of procedure
8. interval of at least 1 hour before next case
9. separate theatre for all such cases

6.5 HAZARDS IN OPERATING THEATRE

SOURCES OF HAZARDS

Staff

Environment

Equipment

Poor Housekeeping

1. poor lay-out of theatre equipment
2. power points inappropriately located so that wirings are strewn all over the floor
3. water on the floor making floor slippery

Electrical Hazards

1. diathermy improperly set-up causing diathermy burns
2. worn out / exposed electrical wires
3. faulty electrical plugs / equipments

Thermal Hazards

1. cold environment for neonates

2. hyperthermia to patients under drapes
3. thermal blankets too hot causing superficial burns

Radiation Hazards

- to staff and patients especially pregnant staff when using image intensifier during hip surgery, percutaneous nephrolithotripsy

Infective Hazards

1. during blood and blood products transfusion
2. poor asepsis control
3. risk to surgical staff operating on hepatitis B or AIDS patients

Chemical Hazards

1. hypersensitivity to cleansing solutions
2. mistaken drugs during intravenous administration and during regional anaesthesia
3. cleansing with alcoholic solution when performing spinal anaesthesia may lead to accidental contamination and neurotoxicity

Anaesthestic Gas Pollution

1. poor scavenging system
2. ? increased teratogenesis / spontaneous abortion in pregnant staff

Physical Hazards

1. hazards during transfer
2. handling of sharp surgical instruments
3. retained swabs / instruments
4. tourniquet duration and pressure injuries at cuff site

Positioning of Patients

1. brachial plexus injury
2. ulnar nerve palsy
3. lateral popliteal nerve in lithototomy position
4. disconnection of anaesthetic tubes

Wrong Identification

1. wrong patient
2. wrong operation
3. wrong side
4. wrong blood transfusion

Laser Hazards

- see section on lasers

6.6 LASERS IN SURGERY

LASER = Light Amplification Stimulated Emission Radiation

Principles of Laser Emission

Comprises of 3 main parts :

1. active material - gas, liquid or solid
2. power source - to excite the molecules of the material to a higher energy level
3. mirrors - to focus the light emitted into a coherent beam of high energy

Physics :

* *molecules brought into a high energy state*
* *energy released when molecule revert to normal energy state, both spontaneous and induced*
* *accurately aligned mirrors system then ensure only light rays in a particular direction are reflected back on themselves to produce a monochromatic, coherent beam*
* *beam can be emitted as continuous or pulsed*

Interactions With Living Tissue

1. Thermal Effect

- energy is absorbed as heat

Three stages : A. reversible effects

B. destruction with subsequent reconstruction by regeneration

C. total destruction with sloughing

2. Thrombosis of Vessels

- secondary to thermal effect

works for small vessel about 1 mm

Advantages of Laser

To Surgeon

1. multiple wavelengths with selective absorption by various tissues
2. transmission through flexible wire guides (except for CO_2 laser)
3. ability to coagulate, vaporise or cut by varying the power and time of application
4. no tissue contact required

To Patient

1. procedures can be done on a day-surgical basis
2. possibility of endoscopic access for otherwise incisional access
3. avoidance of infectious complications of incisional surgery

Hazards of Laser

To Operating Theatre Personnels

1. reflection of laser beam in an unintended direction

2. absorption of laser beam onto skin causing burn

Precautions - eye goggles to absorb energy emitted by the specific laser in use.

warning labels outside operating room when laser in use.

To Patient

1. fires, especially in the oro-pharyngeal cavity with the endotracheal tube (with oxygen-rich gases) in the vicinity

2. damage to normal tissue

Disadvantages of Laser as a Surgical Tool

1. High Cost

2. Requirements of special wiring and plumbing for water cooling

3. Hazards to patient and surgical team

4. Complex maintenance of an evolving technology

5. Nonportability of instruments

6. Special training and accreditation of surgeons required

Types and Characteristics of Lasers Used in Sugery

	Wavelength	Penetration	Absorption	Characteristic
CO_2	10.6 um	0.1mm	water	absorption min scatter high precision
NdYAG	1.06 um	~~1mm~~ 5	pigment cells	absorption scattering
Argon	0.48-0.51 um	~~5mm~~ 1~2	pigment cells	absorption scattering

CLINICAL APPLICATION OF LASER

1. Laser Scalpel (carbon dioxide laser)

* Highly localised effect with minimal damage to surrounding tissue.
* Seals capillary damage, hence decrease oedema and allows for faster healing.
* No mechanical drag.

2. Coagulation (NdYAG laser)

* More scattering and penetration.
* Volume affected much larger than carbon dioxide laser and hence heating process slower
* Ideal for blood vessel coagulation; enhance by high absorption by pigmented cells.
* Debulk tumours by coagulation and sloughing of treated areas rather than controlled excision.

3. Selective Coagulation (argon laser)

* Mainly used in opthalmology and dermatology.
* No absorption in cornea or aqueous humour and hence noninvasive selective coagulation of blood vessels in retina.
* Pass through skin with little effect. Useful in the treatment of portwine stain with minimal scar formation.

4. Photodynamic Therapy

* Administration of non-toxic compound which accumulate in tumour tissue. Subsequent photochemical induction of a toxic

state of this compound using appropriate laser wavelength eg. haematoporphyrin derivative with argon pump laser.

* Applicable for the treatment of bladder carcinoma.

5. Micro-Explosive Effect (NdYAG laser)

* Very high power, short pulses of energy direct to membrane with formation of microplasma - essentially a miniature spark. This results in the mechanical disruption of the membrane.

* Applicable in the removal of membranes appearing as a result of lens replacement surgery in opthalmology.

6. Photofragmentation

* Used in the fragmentation of urinary and biliary stones.

* Pulsed laser of wavelength 504 nm and duration of about 1 nanosec per pulse. Active material used include coumarin green and KTP.

* Action is via formation of "plasma" from vaporisation of a small focus on the stone. The "plasma" is prevented from expansion by the surrounding water and hence pressure builts up which then create an acoustic mechanical stress force on the stone causing it to crack.

* At this wavelength, the laser beams are absorbed by the stone but not by soft tissue and hence harmless when they fall on the body tissue.

6.7 MONOCLONAL ANTIBODIES IN SURGERY

Clinical Application

1 Immunoserology

* hormone assays eg. estimation of thyroid stimulating hormone.
* tumour detection eg. CEA, 3E1-2 MoAb for breast cancer.

2. Immune Monitoring

* MoAb can be used to monitor the population of T-lymphocytes in patients on immunosuppression therapy.

3. Immunohistopathology

* using MoAb to differentiate between malignant and normal cells in fixed preparation.
* using MoAb for confirmation of histological diagnosis eg. prostatic carcinoma by the presence of PSA, thyroid carcinoma by the presence of thyroglobulin
* using MoAb to classify lymphoma.

4. Immunolocalisation of Tumours

* using radioisotopes tagged to MoAb specific for the tumour.

5. Therapeutic Immunotargeting

* tumour therapy using radioisotopes tagged to MoAb specific for the tumour for localised irradiation.

Problems Of MoAb Therapy

1. Toxicity -

   treatable with prednisolone and antihistamines.

2. Antigenic Modulation -

   target cells endocytose the Ag-MoAb complex.

3. Circulating Immune Complexes -

   these are trapped in the kidney resulting in glomerulonephritis

4. Antibodies formation with hypersensitivity reaction in subsequent administration.

5. MoAb Specificity -

   antibodies are monoclonal but are not 100% specific; they can react with 2 different antigens if they share similar epitypes.

The Future

1. Development of more specific and sensitive monoclonal antibodies.

2. Human-derived MoAb to replace mouse-derived MoAb.

6.8 TUMOUR MARKERS

Products of tumour cells which can be used clinically to detect to the presence of tumour cells.

Not necessarily specific for a tumour

Types

1. Foetal protein - carcinoembryonic antigen (CEA) for colonic tumours

   α-foetoprotein (αFP) for hepatoma, testicular tumour

2. Proteins - h-placental lactogen } prostatic Ca

   prostatic-specific antigen } prostatic Ca

3. Enzymes - acid phosphatase for prostatic Ca

4. Immunoglobulins - Bence Jones protein } multiple myeloma

   specific immunoglobulins } multiple myeloma

5. Hormones - calcitonin for medullary thyroid carcinoma

   insulin for insulinomas

   glucagon for glucagonoma

   aldosterone for Conn's (adrenal adenoma)

   h-chorionic gonadotrophin (hCG) for chorio carcinoma and testicular tumour

   somatostatin for somatostatinoma

6. Metabolites - VMA for phaeochromocytoma

HIAA for carcinoids

** while not a product of the tumour, these have also been used as tumour markers :

Epstein-Barr virus serology for nasopharyngeal carcinoma

Philadelphia chromosomes in chronic myeloid leukemia

Clincial Application

1. DIAGNOSIS - VMA for phaeochromocytoma

HIAA for carcinoids

Hormones of endocrine tumors

α FP for hepatoma

2. STAGING - acid phosphatase, PSA for prostatic carcinoma

α FP, hCG for testicular tumors

* presence of acid phosphatase or PSA levels greater than 50 ng/ml indicates probable systemic metastasis

* failure of return to normal values of α FP or HCG after removal of the testis in non-seminomatous germ cell tumour would indicate at least stage II disease

3. PROGNOSIS - α FP indicates poorer prognosis in hepatoma

4. FOLLOW-UP - α FP for hepatoma and testicular tumors

CEA for colonic tumors

Hormones for endocrine tumors

hCG for chorioCa and testicular tumors

PSA for prostatic carcinoma

* Any rise in these tumour markers after an initial fall postoperatively would suggest recurrences. A rising CEA level can give a 3-month lead time before clinical manifestation of chronic recurrences.

5. SCREENING - α FP in hepatitis B carriers for hepatoma

Calcitonin for relatives of Multiple Endocine Neoplasms (MEN) patients

?? PSA for prostatic carcinoma

Ideal Tumour Marker

Tumour specific

Highly sensitive

Easy to assay

NOTES ON SOME USEFUL TUMOUR MARKERS

Prostatic Specific Antigen (PSA)

* produced only by prostate epithelial cells
* serine protease of the kallikrein family
* hydrolyses the coagulum of the ejaculate

* the half-life is about 2-3 days; wait for 2 weeks after any procedure before testing for level, after TURP up to 4 weeks is required for level to return to baseline

* not significantly raised after per-rectal examination; however raised in acute urinary retention,pre-urethral catheterisation and especially after prostatic biopsy, thermotherapy and resection

* organ specific but not cancer-specific

* PSA density :

BPH	0.3 ng/ml per g tissue
Ca prostate	3.4 ng/ml per g tissue

* PSA velocity : refers to the rate of rise in PSA level - > 0.75 ng/ml/ year suggests possibility of prostatic carcinoma

* PSA level in relation to prostatic cancer risk :

< 4 ng/ml	DRE -ve	2.4%
	DRE +ve	31%
> 4 ng/ml	DRE +ve	55%
4-10 ng/ml		20%
> 10 ng/ml	DRE -ve	31%
	DRE +ve	80%

suggested protocol,

PSA <4, DRE -ve -	no further investigation
PSA <4, DRE +ve -	transrectal ultrasound and biopsy
PSA <4-10, with DRE -ve -	transrectal ultrasound and six sectorial random biopsy

estimate PSA density

monitor PSA velocity

* in localised prostatic carcinoma, PSA levels are rarely above 50 ng/ml; if less that 20 ng/ml, bone metastases unlikely

* very useful in monitoring treatment response especially after radical prostatectomy

* problems of PSA as cancer screening tool

20% men with benign prostatic hyperplasia has raised PSA
Upto 30% of prostatic carcinoma have normal level of PSA
Stage D CaP can have normal PSA when the cell of origin is from basal cells

* PSA greatest clinical role is as an immunohistological marker

SUGGESTED READING

JE Oesterling (1991) *Prostate specific antigen* : a critical assessment of the most useful tumour marker for adenocarcinoma of the prostate. J Urol., 145, 907 - 923

GD Chisholm (1993) *Prostate Cancer Screening* : Accepting the Consequences of PSA Testing. Br J Urol., 71, 375 - 377

Alpha-Foetal Protein (α -FP)

* synthesised by yolk sac, liver and gastrointestinal tract epithelial cells

* marker for testicular and liver carcinomas

* raised in teratocarcinoma, yolk sac tumour but not in cases of choriocarcinoma and pure seminoma

* if postorchidectomy level in testicular tumours does not fall to undetectable, it would indicate undectected stage II or III

* also raised in stomach, colonic, pancreas, lung carcinomas and malignant melanoma

* also raised in benign conditions eg. viral hepatitis, alcoholic cirrhosis, ulcerative colitis and Crohn's disease

Carcinoembryonic Antigen (CEA)

* raised in other tumours beside colonic - pancreas, liver, breast, uterus, ovary and bronchus

* also raised in benign conditions - ulcerative colitis, alcoholic liver disease, chronic bronchitis and emphysema

* gives 3 - 6 months lead time in detecting colonic tumour recurrences before clinically detectable

Human Chorionic Gonadotrophin (hCG)

* has alpha and beta subunits; alpha subunit similar to that of Follicular Stimulating Hormone (FSH) and Thyroid Stimulating Hormone (TSH)

* produced by syncytiotrophoblastic cells in testicular tumours; all choriocarcinoma and 60% of teratocarcinoma are expected to have raised level. 5 - 10% of pure seminoma have detectable levels

* serum levels can be raised in pancreatic, stomach and bronchial carcinomas

6.9 IMAGING IN SURGERY

Objectives

1. SCREENING

   * general population screening

   * high risk population screening

2. DIAGNOSTIC

   * detecting anatomical abnormalities

   * defining anatomic extent of lesions

   * characterising lesions to discriminate the various differential diagnoses

   * excluding disease - some clinical diagnoses are diagnosis of exclusion, imaging often invaluable in this setting

3. TREATMENT ASSESSMENT

   * post-treatment assessment

   * detect recurrent / residual disease

Types Of Imaging Techniques

A. X-Rays

Principles

- **x-rays are produced when high-energy electrons strikes a target, usually metallic tungsten**
- **x-rays cannot be focused, so direction of beam is controlled by having lead shields to absorb the unwanted rays**
- **tissue absorption of x-rays varies according to the density of the tissue; air in lung produces little attenuation while calcified tissues absorb much of the beam**

- **detector surface in the form of photographic film, fluoroscopic screen or movable detectors which then records the image in a 2-dimensional summation of the structure which the x-rays beam has passed**

Image Enhancement

1. Contrast media

   - because density of soft tissue and solid organs are too similar to produce differences on plain films, addition of contrast media (which are radiodense) help better delineation of the anatomic details

   * *Barium for gastrointestinal tract examinations*

   * *iodinated aniline dyes for intravascualar administration*

   * *iodinated oils for lymphography and bronchography*

   * *air eg. air encephalogram*

2. Tomography

   - images of a predetermined section of the object of study. Can be conventional or computed

   - conventional tomography obtained by simultaneous movement of x-ray tube and film in opposite directions

   - in computed tomography (CT), x-ray tube rotates around the patient and the degree of x-ray attenuation recorded by detectors fixed around the patient is then registered on a digital basis.The computer subsequently recreates the image. 3 -D images can be constructed

   - to further enhance CT examinations, contrast media can be given

Advantages of CT over conventional tomograms include :

* *better resolution because of no contamination by overlapping tissues*

* *detectors are more efficient in measuring x-ray attenuation than conventional films*

* *allows axial view*

3. Fluoroscopy

- TV monitor coupled to an image intensifier for image recording

* allows visual impression of motility and position of catheter or tubes in the organ under study

* requires contrast media

* allows for choosing of best image for capture on film

4. Dynamic subtraction angiography

- digital subtraction of 2 films, one with contrast, to obtain final picture

* non-invasive - contrast given through peripheral vein.

* useful in outlining vasculature especially peripheral vessels and carotid circulation.

* background image must be stationary, hence not useful for abdominal study where gut movements are present.

Biological Effects Of Ionising Radiation

- *Local Tissue Damage*

- *Teratogenesis*

- *Genetic Damage*

Local tissue damage

* includes erythema, desquamation of epithelial surfaces, vascular damage and subsequent fibrosis

* only occurs in high doses of radiation and never associated with exposure during diagnostic procedures

Teratogenesis

* not certain whether teratogenic effect is dose-related or whether there is a threshold below which it is risk-free
* recent statements from the International Commission of Radiological Protection (ICRP) indicate that the risks to a foetus of irradiation in-utero during the first two weeks of life is very small; hence the ten-day rule is no longer employed in many areas, instead a '28 - day' rule is now used.

Genetic damage

* irradiation of germ cells can cause chromosomal damage with resulting mutations

B. Ultrasonography

Real time

B-mode

Duplex

Doppler

Principles

- **ultrasound waves are produced when a voltage is applied to a material that can be structurally deformed which then resonate and emit ultrasonic waves**
- **by varying size of the piezoelectric disc, the frequency of the ultrasonic beam can be varied**
- **pulses of ultrasonic beams are emitted, followed by a pause to allow for detection of the returning echoes**
- **the beam is attenuated or reflected depending on the physical properties of the tissues**
- **reflected sound energies are converted to electrical signals which are converted by computers into analog echo images**
- **by changing the orientation of the ultrasound probe, sagittal, transverse or oblique views can be obtained**
- **the higher the frequency, the better the resolution, but at the cost of reduced tissue penetration**
- **real-time display allows the images to be continuously displayed on a TV monitor**

- **doppler ultrasound is used for blood flow measurement; the principle is based on the fact that when the ultrasound wave strikes a moving object, the reflected beam is of a different frequency to the incident beam**
- **ultrasound is absorbed by bone, so bony structures act as barrier to ultrasonic imaging**

* non-invasive, simple to perform quick, harmless, cheap and little preparation required; useful as screening tool.

* has replaced oral cholecystogram as basic investigative tool in hepatobiliary and biliary tract disease.

* duplex ultrasound is replacing venogram and arteriogram as investigation of choice in deep vein thrombosis and carotid stenosis respectively.

* wide application in O & G practice and imaging for the urinary tract

* useless in obese patients, ascites and dilated gut when used to assess abdominal conditions.

* operator dependent.

C. Radioisotopes Scan

Tm^{99} scan (liver, bone, thyroid)

Gallium scan (infective focus)

Fe scan (haematopoietic sites, blood pooling)

I^{131} (thyroid, salivary glands, DVT)

Indium - rbc scan (site of GI bleed)

Iodocholesterol scan (adrenal tumours)

Tm^{99} - thallium subtraction scan (parathyroid)

HIDA scan (acute cholecystitis)

Lung ventilation/perfusion scan (PE)

DPTA, DMSA, iodohippurate scan (renal scans)

Principles

- **radiopharmaceuticals (radioactive labelled compounds) localise predominantly in particular organ or groups of organs depending on the compound used**
- **the emitted gamma radiation is then recorded as a measure of uptake, distribution or turnover of the agent within the organ of interest**
- **the radiopharmaceuticals can be radioactive isotopes (eg. I^{131}) or non-radioactive compounds labelled with an isotope (eg. Tm^{99} - tagged rbcs)**
- **must have short half-lives**
- **can be coupled to computer for quantitative measurements in dynamic imaging**
- **dependent on physiology (function) rather than structure (anatomy), hence information obtained different from other imaging modalities which predominantly reflects structural changes; scintigraphy may be positive before structural changes can be detected eg. bone scan for bony metastases**

* useful because site of accumulation fairly specific, however not pathology specific because different pathologies affecting organ function in similar ways can lead to similar scintigraphic result

* diagnostic as well as therapeutic eg. ^{131}I-meta- iodobenzylguanidine for phaeochromocytoma, I^{131} for thyrotoxicosis.

* dynamic studies possible

* renal scan (iodohippurate) useful in situation of poor renal function when IVU unable to outline urinary tract.

* functional status assessment possible eg. DPTA and renal function, I^{131} and functioning thyroid lump.

* single photon emission (computed) tomography using standard radiopharmaceuticals and conventional gamma camera detectors which can be rotated around the patient can be employed to give tomographic slices with the help of a computer (like CT scan). Especially useful when the organ lies deep in the body or when the ratio of activity between the lesion and surrounding tissue is not high.

D. Magnetic Resonance Imaging

Principles

- **based on nuclear properties of the hydrogen atoms in the body.**
- **any atom with a odd total number of protons and neutrons has the nuclear property of spin; hence behaves like a tiny magnet.**
- **usually the axes of spin of the hydrogen nuclei in the body are randomly orientated, but if a strong magnetic field is created the hydrogen nuclei will precess themselves around the lines of the magnetic field.**
- **if very short pulses of radiowaves are introduced, the nuclei absorb the energy and invert their orientation with respect to the magnetic field i.e. they are elevated to a higher energy state.**
- **when the radiofrequency pulses are terminated, the nuclei return to their original orientation in the magnetic field (revert to a low energy state), emitting energy in the form of radiowaves in the process.**
- **the emitted energies from these resonating hydrogen nuclei are collected.**
- **these energy signals emitted contain no innate information defining their origin; thence gradient magnetic coils are needed to vary the magnetic field in space so that the nature of the emitted MR signals from the different body regions are changed to allow exact localisation of the hydrogen nuclei emitting the signals.**
- **a computer then convert these signals into digits, coding them spatially, and reconstruct the information into tomographic body images.**
- **besides hydrogen nuclei, there are other MR-sensitive nuclei including those of phosphorous, sodium and potassium; however these more complex nuclei have lower inherent sensitivities to MR.**
- **these complex nuclei if successfully harnessed for the MR process can have the potential for tissue typing and mapping and use as biologic tracers (MR spectroscopy).**

* good soft tissue resolution especially for imaging of the central nervous system.

* can provide images of various axis of sectioning.

* future application in the identification of tumour cell-type from its magnetic characteristics.

INTERVENTIONAL RADIOLOGY

Angiogram

Percutaneous Transhepatic Cholangiography (PTC)

T-tube manipulation

Cystography

Retrograde / antegrade pyelography

ERCP (Endoscopic Retrograde Cholangiopancreaticogram)

CT- or U/S - guided biopsy / drainage

* diagnostic as well as therapeutic.

A. Diagnostic

1. tissue sampling
2. venous blood sampling
3. diagnosis of lesion from study of its vascular supply eg.hepatoma, renal cell carcinoma

B. Therapeutic

1. embolisation for bleeding, cancer surgery

gelfoam

spring coils

muscle

* *important modality of treatment for expanding pelvic haematoma after pelvic fractures*
* *also popular as alternative to varicocoelectomy*
* *useful in the management of bleeding from angiomyolipomas and polycystic kidneys; no longer advocated for renal cell carcinoma*

2. angioplasty
   * balloon angioplasty
   * laser angioplasty

3. administration of drugs
   * vasopressin for varices
   * streptokinase for acute thrombosis
   * sclerosant eg. thrombovar
   * regional chemotherapy for limb, liver

4. percutaneous drainage of deep abscess, infected biliary tract/urinary tract

5. Balloon dilatation
   * pelvi-ureteric obstruction, ureteric obstruction
   * obstructing oesophageal carcinoma
   * bile duct strictures

INTERVENTION IN THE BILIARY TRACT

1. Retained common bile duct stones
   - lasertripsy, dormia basketry, forceps
   * *working through matured T-tube tract*

2. Stenting for obstructed biliary tract by tumor

    - internal stents

    - external stents

* *problem of obstructed stent requiring replacement*

3. Percutaneous cholecystostomy for gallstones

    - retrieval of gallstones

    - lasertripsy by pulsed-dye laser

    - ultrasonic fragmentation

INTERVENTION IN THE URINARY TRACT

1. Percutaneous nephrostomy
    - relief of acute obstruction
    - drainage of pyonephrosis
    - permanent nephrostomy for malignant ureteric obstruction
    - tract for percutaneous nephrolithotomy and ultrasound lithotripsy

2. Antegrade DJ stenting for ureteric obstruction

3. Drainage of perinephric absess, renal abscess

6.10 AMBULATORY SURGERY

Definition

Any surgical procedure or investigation performed on a planned non-resident basis which nevertheless need recovery facilities

- Royal College of Surgeons

Scope

* 35% of all surgical procedures and 60% of paediatric work can be done on a day surgery basis
* Ambulatory surgical patients should have no less care and safety as in-patients

Concept Of Day Surgery Centre

* either integrated to a hospital, autonomous but attached to a hospital or as an independent surgical centre
* calm and relaxing surroundings
* equipment as complete as hospitals

Patient Selection

1. those procedures requiring only local anaesthesia; ASA I or II for patients who need regional or general anaesthesia
2. medically stable
3. lives within easily accessible medical help eg.general practitioners
4. patient can comply with instructions
5. available accompanying responsible adult on discharge and at home
6. not suitable for very young and very old

Criteria For Procedure

1. duration of surgery less than 90 mins
2. no blood transfusion expected
3. no postoperative pain problem
4. does not need special pre-operative preparation or postoperative nursing care
5. no prolonged immobilisation period expected
6. low postoperative complication rates
7. no major body cavity entered

Advantages Of Day Care Surgery

1. enhanced cost-effectiveness both to patient and health care system.
2. avoidance of depersonalising experience of hospitalisation.
3. minimal disruption of patient's work / family life.
4. reduced opportunity for unnecessary investigations.
5. rapid reduction of surgical lists.
6. reduced child-mother separation time and lessen psychological trauma.
7. decreased risk of hospital-acquired infections.
8. allows hospital staff to concentrate on ill patients.

Disadvantages of Day Surgery

1. reduced rapport with patient.

2. reduced time for postoperative observation and evaluation of post-operative complications.
3. unexpected complications may arise.

PROCEDURES SUITABLE FOR AMBULATORY SURGERY

1. Cardiac Surgery
   * insertion and replacement of pacemakers
   * cardioversion
2. Orthopaedic Surgery
   * carpel tunnel decompression
   * removal of ganglion
   * exostectomy
   * release of trigger finger
   * manipulation under anaesthesia
3. Paediatric Surgery
   * circumcision
   * orchidopexy
   * hernias
   * division of tongue-tie
   * separation of labial and preputial adhesions
   * endoscopies

* marrow puncture
* meatotomy

4. Pain Clinic
   * chemical sympathectomy
   * epidural injections
   * intrathecal injections
   * nerve blocks
5. General Surgery
   * hernias
   * varicose vein avulsions
   * excision of swellings (lipoma, breast lumps)
   * cystoscopy
   * nail bed ablation
   * anal dilatation
   * endoscopies
6. ENT Surgery
   * myringotomy and insertion of grommets
   * antrostomies
   * nasal polypectomy
   * submucous diathermy
   * adenoidectomy

* microlaryngoscopy
* bronchoscopy

The introduction of minimal invasive surgery has greatly increased the scope of day surgical procedures. Laparoscopic cholecystectomy, laparoscopic pelvic lymphadenectomy and laparoscopic gynaecological procedures are now performed on a day-surgical basis.

Advice to Day-surgery Patients

A. YOU ARE ADVISED NOT TO PERFORM THE FOLLOWING TASKS WITHIN 24 HOURS OF ANAESTHESIA / SURGERY :

1. Not to drive a vehicle, ride a motorcycle or use a bicycle.
2. Not to operate any machinery or dangerous tools.
3. Not to perform any task that requires skill, co-ordination or judgement (eg. financial transactions, legal documentations, ATM withdrawal etc.).
4. Not to drink alcohol or take medicine such as sleeping pills, tranquilizers.

B. PLEASE CONTACT THE HOSPITAL ACCIDENT & EMERGENCY DEPARTMENT IF YOU HAVE THE FOLLOWING PROBLEMS AFTER SURGERY. BRING ALONG ANY HOSPITAL CARDS, MEMO ETC.

1. Excessive pain or headache not controlled by pain killer given by the ward doctor.
2. Excessive nausea and vomiting and unable to retain oral feeds.
3. Unable to pass urine 12 hours after operation.
4. Excessive bleeding from the wound.
5. Unexpected drowsiness.
6. Unexpected weakness of limbs.

Future Developments

Extension of the ambulatory surgical services to postoperative care services whereby recovery and convalescence is outside of the hospital environment (thereby freeing hospital facilities for acute and emergency services) but still within reach of specialist medical assistance. Such aftercare services would include hospital hotels (hotels next to the hospital), out-patient observation units, medical hotels (where staff are trained in first aid and resuscitation) and free-standing recovery centers. They will allow for even greater scope to the concept of day care surgery.

FURTHER READING

Commission of the Provision of Surgical Services : *Guidelines for Day Case Surgery* (1985). London, Royal College of Surgeons of England

6.11 SURGICAL AUDIT

2 aspects : *hospital administration*

clinical audit

Hospital Administration

* admissions (emergency vs elective)
* surgical procedures (day surgery vs inpatients)
* facilities utilisation

Benefits : 1. help planning of manpower requirements and deployment to maximise utilisation facilities

2. future planning for upgrading of facilities (priorities and types of improvement)

Clincial Audit

* mortality
* morbidity
* treatment outcome

Organised as : mortality and morbidity rounds

clinical studies

Benefits : 1. personal - self-appraisal

2. departmental - staff appraisal

clinical research/studies

quality of care measurement

ABUSES OF SURGICAL AUDIT :

Hospital Management

- compromise care in order to achieve better statistics eg. earlier discharges to improve bed utilisation and admission rates

Clinical Results

- personal rivalries
- interdepartmental rivalries
- interhospital rivalries

HOW TO START AN AUDIT PROGRAMME :

1. Initiator - an interested person
2. Departmental- audit rounds (elective, emergency surgery; mortality and morbidity)
3. Monthly reports of departmental clinical activities (admissions, outpatients)
4. Clinical Studies - retrospective
5. Plan data collection, storage and retrieval

   Important Considerations -

   * *easy to fill forms*
   * *deliberate, comprehensive data entry form*
   * *minimal secretarial/clerical efforts*
   * *appropriate computer software*

6.12 PRINCIPLES OF FRACTURE MANAGEMENT

Three considerations

1. *Associated injuries may be life-threatening and hence of greater priority in management (see section on MULTIPLE INJURIES)*
2. *Management of associated soft tissue damage*
3. *Type of Fracture - close or open*

Radiograms : Rule of Twos

2 views

2 occasions (2 weeks later)

2 joints (Monteggia, Galeazzi)

2 limbs (for comparisons)

Types Of Fracture Healing

1. Primary or contact healing

With direct contact, osteoclasts cross from one bone to another, resorbing bone. New bone is laid down in the resorbed areas (as in remodelling). The process is slow and full strength is achieved after a long period of remodelling. However, even in the best reduction, there are many areas of small gaps where osteoid is laid down (as in secondary healing).

* absolute rigidity and perfect anatomical reduction required
* no callus formation, hence unable to assess clinical healing
* achieved by rigid internal fixation

2. Secondary or gap healing

Natural way of fracture healing whereby the haematoma around the fracture ends are invaded and replaced, first by granulation tissue which then differentiates into connective tissue, fibrocartilage and bone. Finally remodelling of the callus occurs.

* stable fixation but no absolute rigidity
* bone healing require stress and some movement to stimulate callus formation
* more physiological

Factors Affecting Bone Repair

1. General
   a. nutrition (protein, Vitamin C deficiency)
   b. metabolic diseases (diabetes, steroid)
   c. anaemia
2. Local
   a. immobilisation of fracture
   b. fracture pattern and reduction
   c. interposition of soft tissue between fractured ends
   d. infection
   e. amount of soft tissue damage and hence local ischaemia
   f. integrity of local blood supply

Complications

1. Fat Embolism
   - affects pulmonary and cerebral circulations
   - clinically manifests as hypoxia, restlessness
   - serial blood gas monitoring mandatory; if pO_2 below 60mmHg, consider assisted ventilation
2. Volkmann's Ischaemia/Contracture
   - compartmental syndrome from increased pressure within fascial compartment
   - intra-compartmental pressures should be monitored
   - fasciotomy may be required, either open or closed
   - 6 Ps : pain, pulselessness, pallor, paraesthesia, paralysis, poor capillary return (signs to look out for)
   - late fibrosis affects flexor compartment and intrinsic muscles
3. Venous Thrombosis
   - from immobilisation (venous stasis)
   - injury of veins in lower limb fractures (endothelial damage)
   - hypercoagulable blood from tissue thromboplastin release
4. Crush Syndrome
   - release of myoglobin which damages the renal tubules resulting in renal failure
5. Tendon Rupture
   - can occur at time of trauma (primary rupture)

- delayed rupture is a result of ischaemia eg. extensor pollicis longus tendon rupture in Colle's fracture

6. Nerve Injury

- direct injury
- compression injury from oedema / haematoma
- late neuropathy eg. ulnar neuritis from decubitus valgus deformity secondary to childhood lateral condylar fracture of elbow

7. Myositis Ossificans

- ossification of soft tissue around fracture
- if across joints, can impede joint movements

8. Growth Disturbances

- late deformities eg. decubitus valgus after fracture separation of lateral condylar epiphysis
- Salter-Harris Type III to V injuries can damage growth plate with resultant limb length discrepancy
- increased vascularity to growth plate during fracture healing leading to limb length discrepancy

9. Reflex Sympathetic Dystrophy

- cause unknown ? increased autonomic discharge
- usually after minor trauma; sometimes secondary to acute myocardial infarction

10. Missed Dislocation

- Monteggia fracture with missed radial head dislocation

11. Osteoarthritis

- Monteggia fracture with misssed radial head dislocation
- fractures resulting in avascular necrosis eg. wrist osteoarthritis after avascular necrosis of scaphoid following fracture of the bone
- mal-union with changes in force transmission

12. Avascular Necrosis

- occurs when the blood supply to a part of the bone is cut off following the fracture
- seen after fractures of talus, head of femur, scaphoid and humeral neck
- can result in secondary osteoarthritis

13. Delayed Union

- inadequate immobilisation of fracture
- excessive traction pulling ends apart
- infection
- inadequate blood supply especially where no muscles are attached eg. lower end of tibia, talus
- internal fixation with loss of fracture haematoma and normal stress (taken by metallic implants)
- if the paired fellow bone is intact and hence holding ends apart eg. intact fibula with tibial fracture

14. Non-Union

- occurs if there is soft tissue interposition or too large a gap
- hypertrophic or atrophic type

- hypertrophic type (evidence of callus formation) may be treated conservatively with functional bracing, electrical stimulation, or surgically with rigid internal fixation

- atrophic type (no evidence of callus formation) requires bone grafts

15. Malunion

- fracture not adequately reduced or held

- may require no treatment (decubitus varus after supracondylar fracture), raised shoe (shortening in lower limb), corrective osteotomy or soft tissue surgery (ulnar nerve transposition with decubitus valgus)

PRINCIPLES OF MANAGEMENT

Adequate Reduction

Hold

Rehabilitate

TREATMENT OF CLOSED FRACTURES

Reduction

A. Closed

B. Open

Close reduction

1. understand traumatic forces

2. muscle relaxation, general anaesthesia if necessary

3. traction

4. reverse force applied

Open reduction

1. when closed reduction unsuccessful or impossible eg. soft tissue interpostion

2. when accurate reduction required eg. intra-articular fracture, forearm fractures

Hold

A. *Continuous Traction*

B. *Plaster Cast*

C. *Fracture Bracing*

D. *Metal Fixation - internal*

- external

Continuous Traction - skeletal traction with steinmann pins

- skin traction

- by gravity alone eg. triangular bandage for upper limb fractures

Traction can be FIXED (Thomas' splint), BALANCED TRACTION (body weight provided an opposing force with the foot of the bed raised) or COMBINED (where the limb is attached to a splint and the splint is suspended to the foot of the bed which is raised)

Plaster Cast - plaster of paris or fibreglass

- allow for post-fracture oedema (split plaster initally)
- immobilisation of joints can lead to stiffness
- window can be created
- careful of bony prominences causing pressure sores

Technique of delayed splintage to overcome problem of joint stiffness - traction initially to allow joint exercises and then applying plaster later.

Fracture Bracing

- based on principle that a circumferential brace can increase stiffness of a limb with a fracture by over 100X through soft tissue compression
- effectively maintain angulatory alignment
- contra-indicated in unreliable or unco-operative patients, unacceptable reduction, severe soft tissue damage and when there is associated neurological or vascular impairments
- it is functional in that it allows joint movement
- may not completely immobilise fractures, however activity encourages callus formation and bone remodelling (Wolff's Law)

Metal Fixation

- metal appliances to hold fracture securely; hence early joint movements allowed
- however metal appliances has breaking point and is unlike mature callus and hence weight-bearing is unsafe till fracture unites
- types used include screws, pins, plates, wires, rods

* Indications for internal fixation includes :

  failed closed methods

  displaced intra-articular fractures

  displaced epiphyseal fractures

  major avulsion fracture eg. patella, olecranon

  associated vascular injuries

  non-union

  multiple fractures

  pathological fractures

  to aid nursing care after spinal injuries

  where closed methods ineffective especially in forearm fractures where muscular actions tend to supinate / pronate so that satisfactory alignment difficult to maintain

  to allow faster rehabilitation especially in the elderly patients with hip fractures

* time-table for removal of implants :

  upper limb - at least after 6 months

  lower limb - at least after 1 year

* sepsis may be complicated by the presence of a foreign body

* problem of poorer fracture healing because stress is taken by the metal implants (Wolff's Law)

* problem of metal fatigue and fracture

* external fixators more commonly employed in open fractures, however closed pelvic fractures can be held by external fixation

Rehabilitate

A. *Elevation to reduce oedema*

B. *Move non-involved joints*

C. *Exercise muscular groups*

Other Techniques

A. Joint replacement in elderly for fracture neck of femur with grade 3 or 4 Garden's grading

B. Immobilising finger fracture by splinting it to adjacent finger

TREATMENT OF OPEN FRACTURES

Soft tissue management more important than fracture management

Classification (Gustillo)

TYPE I

- puncture wound 1 cm or less

relatively clean

no crushing component

* *fracture pattern is usually simple transverse, short oblique type with minimal comminution*

* *most likely fracture ends pierces skin from inside*

TYPE II

- laceration more than 1 cm long

no extensive soft tissue damage

minimal to moderate crushing component

* *fracture usually simple transverse or short oblique type with minimal comminution*

TYPE III

- extensive soft tissue damage

high velocity injury

severe crushing component

open fracture with neurovascular injury

open fracture over eight hours old

farm / battle injuries

traumatic amputations

A : soft tissue cover possible

B : soft tissue cover impossible because of extensive loss

C : associated neurovascular injury

MANAGEMENT :

1. Pre-operative antibiotics /tetanus prophylaxis
2. Mechanical irrigation and washing
3. Debridement

skin - preserve

fascia - divide extensively

muscle - generous excision

nerve - leave alone if wound dirty

tendon - same as for nerve

bone - preserve

4. Internal fixation allowed in Type II fractures

5. External fixation usually required in Type III fractures (through and through or one-sided type fixators with 4 pins above and 4 pins below fracture)

6. Flaps may be required for Type IIIb fractures to provide skin cover especially when tendons, nerves, arteries or bare bone exposed.

7. Delayed skin closure.

RECOMMENDED READING

Principles Of Fracture (1982) In : Apley AG, Solomon (eds) Apley's *System Of Orthopaedics And Fractures*. Butterworth, UK.

6.13 FACTORS TO CONSIDER WHEN SETTING UP OPERATING THEATRE

Location

1. away from noisy / busy areas
2. easy access from - emergency unit
   intensive care unit
   wards

Number Of Theatres

- workload
- staffing

Nature Of Theatres

- operating rooms for "clean" and "dirty (infective)" cases
- emergency vs elective
- endoscopy room
- day surgery theatre

Zoning Of Theatres

1. sterile zone - preparation room
   - operating room
2. clean zone - scrub room

- anaesthetic room
- rest of operating room

3. dirty zone - change room
- sluice room

Setup Facilities

1. VENTILATION
   - laminar flow
   - air condition
   - air flow from sterile to dirty zone
   - exhaust for anaesthetic gases
2. LIGHTING
   - not too glaring
3. ELECTRICAL
   - adequate number and appropriately placed power points
4. GASES
   - right tubes with correct and easily identifiable colour coding
5. OTHER EQUIPMENT
   - eg. monitoring screens, equipments

Ancillary Facilities

- central sterile supply department

- X-Ray / image intensifier
- laboratories and frozen section facilities
- blood bank
- storage area
- teaching facilities eg. video-camera and viewing room, conference rooms

Others

- rest room for staff
- changing room facilities
- reception area
- recovery area

6.14 ANTIBIOTICS IN SURGICAL PRACTICE

TYPES OF THERAPY

Prophylactic

Therapeutic

Empirical

Principles Of Antibiotic Prophylaxis

1. Antibiotic must be present in wound at time of innoculation of infective agents
2. Coverage should include all potential infective agents
3. Should be bactericidal antibiotics
4. Antibiotic should not be part of treatment armamentarium
5. Short duration therapy is sufficient (single dose if long half-life or 3 doses)
6. Prophylaxis appropriate only in high risk clean operations (eg. vascular surgery, joint replacements) or in clean contaminated operations (eg. colectomies)

Principles Of Therapeutic Treatment

1. Full course of at least 5 days, in certain clinical situations longer therapy (osteomyelitis, endocarditis) or shorter therapy (lower urinary tract infection, gonorrhoea, syphilis) may be indicated.
2. Choice of antibiotics should be guided by sensitivity studies

3. In-vitro sensitivity may not correlate to in-vivo effectiveness and hence clinical response to therapeutic doses should be the final determining factor

4. Antibiotics cannot substitute surgical drainage of abscess

5. In renal and hepatic impairment, dosages should be titrated with regular serum level measurements. INTERVAL EXTENSION regime (time between doses extended) or DOSE REDUCTION regime (standard initial dose followed by reduced maintenance doses) can be employed.

Principles Of Empirical Therapy

1. Required when sensitivity results not ready but clinical conditions require treatment

2. Choice of drugs should cover expected pathogens based on local community studies

3. Trial of treatment for suspected tuberculosis

NOTES ON COMMONLY USED ANTIBIOTICS

Beta-Lactam Antibiotics

Penicillins

Cephalosporins

Mode of action

- inhibit synthesis of muramic acid required for bacterial cell wall formation

Penicillins

Penicillinase-sensitive :	**Ampicillin**
	Piperacillin
	Carbenicillin
	Ticarcillin
Penicillinase-resistant :	**Cloxacillin**
	Imipenem (Tienam)
With inhibitors :	**Augmentin (amoxycillin with clavulinic acid)**
	Unasyn (ampicillin with sulbactam)

* useful against G+ve organism and some anaerobes
* later generations effective against Pseudomonas and Proteus
* problem of hypersensitivity (10-15%) with anaphylaxis occuring in 0.015 - 0.04% of patients

Cephalosporins

1st Generation :	**Cephalexin**
	Cephaloridine
2nd Generation :	**Cefemandole**
	Cefoxitin
3rd Generation :	**Ceftriaxone (Rocephine)**
	Ceftazidime (Fortum)
	Cefoperazone (Cefobid)

* broad-spectrum action covering enteric organisms and anaerobes
* 10% cross-sensitivity with penicillins
* nephrotoxicity
* 2nd generation drugs have greater activity against G-ve organisms because of greater stability against beta-lactamase, however less effective against G+ve
* 3rd generation drugs has poor activity against staphylococci but greater activity against G-ve bacilli

4th cefepime

Aminoglycosides

Gentamycin
Amikacin
Neomycin
Kanamycin
Streptomycin

Vancomycin Clindamycin

Mode of action

- cause misreading of mRNA thereby inhibiting protein synthesis

* effective against G-ve organisms
* problem of nephrotoxicity and ototoxicity
* potentiates muscle relaxants in high doses
* parenteral administration only
* clindamycin cause pseudomembranous colitis
* vancomycin is useful for MRSA
* neomycin is used in local sterilisation of gut organisms

Quinolones

Nalidixic acid
Perfloxacine
Norfloxacin
Ciprofloxacin

Mode of action

- inhibits bacterial gyrase

* useful in urinary tract infections

* cause haemolysis in G6PD deficient patients

Macrolides

Erythromycin
Clarithromycin

Mode of action

- interferes with translocation of aminoacids by binding to 50S fraction of bacterial ribosomes, thereby inhibiting protein synthesis

* alternative to penicillin for those who are allergic to them

* broad-spectrum activity including pencillinase-producing organisms

* gastrointestinal upsets common

* bacteriostatic agents

Metronidazole (Flagyl)

Mode of action

- binds to DNA and inhibits nucleic acid synthesis

* used mainly for parasitic and anaerobic infections

* main side-effects include metallic taste, diarrhoea and colours urine red

Sulphonamides And Trimethoprim Combination

Trimethoprim and Sulphamethaxazole (Bactrim)
Trimethoprim and Sulphadiazine (Septrim)

Mode of action

- sulphonamides competes with para-aminobenzoic acid for dihydropteroate synthetase

  trimethoprim inhibits dihydrofolate reductase

* useful for UTI (penetrates prostate), typhoid and non-specific urethritis

Anti-Fungal Drugs

Polyene Antibiotics -	**Amphotericin**
	Nystatin
Flucytocine	
Imidazoles -	**Clotrimazole**
	Miconazole
	Ketoconazole

Mode of action

- polyene binds to sterol component of cell wall causing increased permeability

  imidazoles probably damages fungal cell membrane

* amphotericin B is still the most useful antifungal agent for systemic mycosis

* adverse reactions to amphotericin B includes hypotension, thrombophlebitis, nephrotoxicity, peripheral neuropathy and paraplegia (when given intrathecally)

* imidazoles less toxic but also less superior in efficacy

* griseofulvin useful only for dermatophytes

6.15 ASSESSMENT OF ORGAN FUNCTION

Oesophagus

1. Motility : manometry

   isotope-labelled food

   barium swallow

2. Reflux : isotope-labelled food

   24-hours pH monitoring

   Bernstein's test of acid instillation

   barium swallow

* radiological reflux does not correlate to clinical reflux

1. The pressures along the oesophagus are :

cricopharyngeus :	**50 to 100 mmHg**
cardio-oesophageal :	**15 to 40 mmHg above gastric pressure**
peristalsis :	**50 to 100 mmHg**
resting oesophageal :	**reflects intrapleural pressure**

2. Barium swallow features help to identify motility disorders eg. distended proximal oesophagus with tapering end in achalasia

3. The 24-hours pH monitoring will indicate the efficiency of acid clearance from the distal oesphagus which is a more important factor in clinical reflux oesophagitis than the presence of reflux which is a normal occurence

4. By studying the radioactivity pattern when swallowing food tainted with radioisotopes, motility dysfunction and presence of reflux can be studied

Stomach

Secretory : histamine / pentagastrine challange

Hollander's test

* Vital dye study

* pH probe

* intraoperative test (response to pentagastrin or histamine stimulation) to assess completeness of vagal denervation.

1. **Pentagastrin test :**
   measure basal acid output (BAO) over 1 hour followed by peak acid output (PAO) after administration of 6ug/kg BW pentagastrin. BAO/PAO > 0.6 usually indicate Zollinger Ellison Syndrome. PAO is derived by measuring secretions over 15 mins periods for 1 hour and then multiplying the maximal response of the 4 readings by 4. There is too much overlap between the basal acid output of patients with gastric ulcers and duodenal ulcers to make this assessment useful for ulcer differentiation. However post-vagotomy PAO of > 20 mmol/h indicate a persisting hypersecretory state while PAO < 10 mmol/h usually means recurrent duodenal ulceration is unlikely.
2. **Hollander's test :**
   insulin-induced hypoglycemia will create the stress for increased vagal tone and hence increased acid production. Insulin is given 0.2u/BW after measuring basal secretion. Acid secretion for the next 2 hours is measured in 15 minutes period. With any 15-min sample with a conc of > 20 mmol/l compared to the basal secretion, the test is positive. Early responders (within 1 hour) have significant vagal innervation. Later response (those in the second hour) are not necessarily significant. However,it is only useful for assessment of completeness of vagotomy immediately postoperatively; the test can yield normal results 6 months postoperatively though the test performed shortly after surgery may show complete denervation of the vagus.
3. **The vital dye and pH probe are two tests that can be used to map the area of denervation of the stomach during surgery; alternatively electrical stimulation to the vagus can be applied and corresponding gastric peristalsis is noted.**

* Secretory tests are indicated only for those with recurrent or intractable peptic ulceration.

* In addition to above test, serum gastrin levels should also be taken to assess the hormonal stimulus to hypersecretion. Hypergastrinemia can be found in retained antrum, hyperplasia of the G cells of the antrum or gastrinoma. When levels are in the thousands, this usually indicate gastrinoma. Gastrinoma will also show exaggerated response to administrations of secretin and calcium.

* Hypercalcemia can be associated with hyperacidity and hence serum

calcium should be measured. If an associated hyperparathyroidism is corrected, the gastrin level may fall to normal.

Pancreas

Lundh test

Secretin provocation test

1. **Lundh test consists of giving a meal of fat and measuring the response of pancreatic lipase secretion in the duodenal aspirate.**
2. **Secretin test : same as above except that secretin is administered parenterally.**
3. **Increase faecal fat suggests fat malabsorption and is an indication of pancreatic dysfunction though this occur only when 80% of the pancreatic secretory capacity is lost.**

Gallbladder

Fatty meal

Cholecystokinin

1. **The contraction of the gallbladder is studied under fluoroscopy (oral cholecystogram) or during HIDA scan**

Liver

A. Synthetic function : albumin, globulin levels

vit K-dependent clotting factors

B. Excretory function : galactose elimination (enzymic)

indocyanine green excretion

bromsulphthalein excretion

serum bilirubin (bile excretion)

bromsulphthalein excretion

serum bilirubin (bile excretion)

C. RBC destruction and formation : isotope-labelled rbc
radioactive iron

1. **95% of bromsulphthalein should be cleared within 45 mins of administration. Delayed clearance would indicate conjugation dysfunction.**
2. **Cr tagged-rbc : the collection of radioactivity over the liver will indicated rbc destruction / pooling; similarly the accumulation of radioactive Fe will indicate the liver as the site of rbc formation in myelofibrosis.**
3. **Direct and indirect bilirubin measurement will indicate whether the pathology is in the liver parenchyma (raised indirect bilirubin) as opposed to a biliary pathology where conjugated bilirubin spills into the circulation. This information can also be obtained indirectly by finding bile in the urine and a low concentration of bile porducts in the stool (biliary obstruction).**
4. **Prolonged prothrombin time is one of the earliest indication of liver dysfunction.**

* Parenchyma damage is indicated by raised liver enzymes in the serum eg. AST, ALT, yGT.

* Biliary tract obstruction is indicated by raised serum alkaline phosphatase and y-glutamyl transferase. The corresponding raised yGT will indicate that the alkaline phosphatase is of hepatobiliary origin.

* Scoring system for assessment of liver function : (Child's classification with Pugh's modification)

Child's Classification

	A	B	C
Bilirubin (mg/L)	<2.0	2-3	>3
Albumin (g/L)	>3.5	3-3.5	<3
Ascites	None	Easy control	Poor control
Encephalopathy	None	Mild	Advance
Nutrition	Excellent	Good	Poor

Pugh's Modification

Points	1	2	3
Encephalopathy	None	Mild	Advance
Ascites	None	Slight	Moderate
Bilirubin (mg/L)	1-2	2-3	>3
Albumin (g/L)	3.5	2.8-3.5	<2.8
PT (sec)	1-4	4-6	>6

A = 5-6 points

B = 7-9 points

C = 10-15 points

* this scoring system is usefully in the selection of patient for portal vein decompression procedures; Child's C patients usually do poorly.

Thyroid

A. Biochemical : serum T_4

serum T_3

Free thyroxine index

B. Radioactive iodine scan : uptake of iodine and secretion of thyroxine

C. Immunoassay : thyroglobulin

parathyroid hormones

* anti-microsomal antibodies

* anti-thyroglobulin antibodies

* *They are autoimmune antibodies whose presence suggest autoimmune thyroiditis*

Serum T_4 varies in conditions that alters the degree of the binding protein eg. pregnancy or starvation; hence in this condition the free serum thyroxine level is a more accurate assessment

Renal Function

A. Urine : output (per-urethra / percutaneous nephrostomy)

specific gravity / osmolality

microscopic examination (casts, epithelial)

electrolytes (Na, K)

B. Creatinine clearance

C. Acidification of urine

D. Urine concentrating ability

E. Imaging :

intravenous urogram

dynamic radionucleotide study : DTPA

1. The kidneys should produce at least 0.5 ml/min of urine for adequate excretion of metabolites (at least 1 ml/min in children); the individual kidney output and functions (eg. acidification, concentrating ability and diuresis). can be measured via a percutaneous nephrostomy. This is the best method of assessing individual renal function.
2. Urine specific gravity : test ability to concentrate and dilute urine (medullary countercurrent system). Fluid is withheld for twelve hours overnight; the SG of the first two morning specimens should reach 1.020. A litre of water is then given. Within four hours the SG of urine should be as low as 1.002. A fixed SG of 1.010 under varying conditions indicate impaired tubular function (i.e. specific gravity similar to that of glomerular filtrate). Alternatively, urine osmolality can be measured. Any specimen of urine greater than 800 mmol/L means that the concentrating ability of the kidney is normal.
3. Microscopic examination of the urine can give much information : casts will indicate leakage of protein; epithelial cells suggest glomerulonephritis
4. The measurement of urinary electrolytes will indicate the ability of the kidneys to conserve electrolytes eg. urinary Na is high in salt-losing nephropathy
5. Creatinine clearance : this is a measure of glomerular filtration rate. The normal clearance is 80 - 120 mls/min. Creatinine clearance is calculated by : $\frac{\text{Conc in urine x vol of urine}}{\text{conc in plasma}}$
6. The urine is usually slightly acidic. Hence if the urine from a kidney is acidic, then the kidney is functional. The ability to acidify can also be tested by administering ammonium chloride; the ammonium salt is metabolised to ammonia (further converted to urea) and hydrogen ions.
7. The concentrating ability of the distal tubules can be tested by giving anti-diuretic hormone and measuring the increase in urine osmolality
8. Intravenous urogram : sodium diatrizoate (which is ionic) is mainly secreted by the proximal tubules. Non-ionic contrast which is more commonly used includes Omnipaque (iohexol) and Ultravist 370 (iopromide). Non-opacification of the kidney indicates poor function.
9. Dynamic study with DTPA can assess differential function of the kidneys in terms of percentage contribution of renal function by each kidney as well as demonstrate the presence of obstruction. However as a measure of renal function in an obstructed system, the radioactive counts can be misleading because of accumulation of radioisotopes in the pelvicalyceal system in contrast to clearance of the radioisotopes in the normal side. DTPA is excreted by glomerular filtration and hence measure glomerular function. DMSA, on the other hand is taken up by the renal parenchyma but not excreted.

^{123}I- hippuran is a better radiopharmaceutical compound compared to DTPA in assessing renal function; it is both filtered and secreted by the tubules. However ^{123}I-hippuran has a very short half-life and hence the source must be near the nuclear medicine laboratory, precluding its availability. Mercaptoacetyltriglycerine (MAC-3) is the next best alternative : it is an analogue of ortholodohippuran, showing 60% of the clearance and sharing the similar physiologic characteristics as hippuran.

** In the interpretation of the F+20 or F-15 diuresis renogram (in assessing obstruction), the individual renal function is an important consideration because it demonstrates functional obstruction at the induced flow rate. If urine output is low, the urine can be cleared from the pelvicalyceal system even in the face of a partial anatomical obstruction. That is to say that each system has its maximal urine flow rate and if the normal flow rates do not exceed this capacity than there is no significant clinical obstruction. In diuresis renogram or the perfusion pressure flow studies (Whitaker test), the flow rates induced may not be accurate as they may be too high compared to the normal situation and yet not high enough to simulate highly stressed conditions such as alcohol diuresis when significant obstruction may be precipitated. In the Whitaker test, the flow rate is set at 10 mls/min whilst in the diuresis renogram, the rate is determined by the ability of the kidney to respond to frusemide (hence a more physiological

Bladder Function

A. Detrussor Function : Filling cystometry

Micturiting cystometry

B. Outlet Resistance : Urethral Profilometry

C. Urine Flow Assessment : Uroflowmetry

D. Videourodynamics

E. Ambulatory urodynamics

F. Sphincter electromyography

1. Filling cystometry

Parameters : Detrussor- activity (normal or overactive)
capacity
compliance

Sensation (normal, hypersensitive, hyposensitive or absent)
Urethral Function (normal or incompetent)

The bladder is filled with water / gas and the intravesical pressure is measured by a transducer. The detrussor activity is a calculated value obtained by the difference between the intravesical pressure and the intra-abdominal pressure which is recorded by a rectal tranducer. The bladder should exhibit receptive relaxation so that the intravesical pressure does not rise with infusion of water. The behaviour of the detrussor, bladder sensation and urethral function are noted. Under detrussor behaviour, its activity (normal or overactive), capacity and compliance is recorded. Bladder sensation is classified as normal, hypersensitive, hyposensitive or absent. Urethral function is recorded as normal or incompetent (leakages noted). In upper motor neurone lesion of the bladder, there is poor compliance (intravesical pressure rise with distension); with associated detrussor overactivity (involuntary, unstable contractions). In lower motor neurone type of neurogenic bladder ,the bladder can be greatly distended without any urge to micturate (high capacity, high compliance). In cases of urge incontinence and detrussor instability, provocative tests such as coughing may be needed to demonstrate unstable detrussor contractions (must be >15 cmH_2O); however upto 50% of detrussor instability may not be detected on standard urodynamic study. Efficacy of anti-cholinergics for detrussor instability can also be assessed with pre- and post- medication studies. Low compliance from neurogenic causes can be differentiated from primary bladder pathology (fibrosis, interstitial cystitis) by neuro physiological tests (see later section).

2. Micturiting cystometry

Parameters : Detrussor (normal, underactive or acontractile)
Urethral (co-ordinated or obstructed)

Towards bladder capacity (about 400 - 500 mls) there is a rise in intravesical pressure associated with an urge to micturite. The detrussor will exhibit a SUSTAINED contraction until the water is completely voided. In this study, the detrussor is classified as normal, underactive (contraction noted but emptying is incomplete) or

acontractile. In upper motor neurone lesion, mass reflex can initiate detrussor contractions (reflex voiding), but they are not sustained for complete emptying; there is a lack of augmentation by the pontine micturiting centre. In lesions affecting the final nerve pathways to the detrussor, there will be acontractility. Voiding, if present, will be by abdominal straining which will be demonstrated in the urodynamic tracing by an increase in the pressure recording of the rectal transducer. Acontractility resulting from neurogenic causes can be differentiated from non-neurogenic causes by the bethanocol test. Subcutaneous bethanocol (cholinergic) administration will result in detrussor contractions in neurogenic lesions.

Urethral function is classified as co-ordinated or obstructive. Opening pressure (the intravesical pressure when urine flow is initiated) above 80 cm H_2O indicate bladder outlet obstruction. If no mechanical obstruction is present, this would suggest detrussor-sphincter dyssynergia. Bladder outlet obstruction is also suggested by a high voiding pressure (detrussor pressure > 100 cm H_2O irregardless of flow rate; or detrussor pressure > 60 cm H_2O with flow rate < 15 ml/s). There are pressure-flow plots available (Abram Griffiths, Schafer) with which the pressure-flow characteristic can be plotted and, a diagnosis of bladder outlet obstruction confirmed or excluded.

3. Profilometry

Urethral closure pressure profile (UCPP)
Micturiting urethral pressure profile (MUPP)
Stress urethral pressure profile (SUPP)

The pressure profile is measured and the functional length of the urethra (length of the urethra where the pressure is above intravesical pressure) noted. In the female, it is 3 cm and in the male 5-7 cm. The maximum closure pressure refers to the greatest difference between the urethral pressure and the intravesical pressure. There are three types of studies : urethral closure presure profile (UCPP), micturiting urethral pressure profile (MUPP) and stress urethral pressure profile (SUPP). The first is done during resting condition, the second during micturition and the third with stress (coughing,

Valvalsa). Of these, the MUPP is the most informative because it provides information that is of clinical significance. UCPP provides information on rest continence while SUPP studies on stress continence.

4. Uroflowmetry

Parameters : Maximum flow rate (Qmax)
Flow time
Time to maximum flow

It is the screening test of micturition. The maximum flow-rate and pattern is monitored. Poor flow-rate (normal 15-20 mls/s for males; 20-25 mls/s for females) indicates either increased outlet resistance or poor detrussor function. The normal flow curve is of a bell-shaped pattern with a moderate steep rise; in obstructed flow the pattern is flattened. Abdominal straining can also be detected by the intermittent pattern of urine flow.

Time to maximum flow should not exceed one-third point of the flow time. Long flow time or maximum flow occuring much later during the flow duration are signs of bladder outlet obstruction if poor detrussor function is excluded.

A urine flow of at least 150 mls is needed for proper interpretation of the results. Comparison with uroflow normograms (Bristol Normogram) should be made.

5. Videourodynamic

In this study, radiological contrast is used instead of water / saline. During the study, the bladder is screened and any pelvic descent on coughing is noted together with any leakage. This demonstrate stress incontinence. At the same time vesico-ureteric reflux should also be noted. Detrussor-sphincter dyssynergia as opposed to detrussor-bladder neck dyssynergia (or neuropathic urethra) can also be determined by observing for bladder neck opening but anatomical obstruction at the level of the striated sphincter. The bladder contour and any diverticuli can also be picked up during the screening. Associated genitourinary lesions may be identified.

6. Ambulatory urodynamics

This is performed on a 4-6 hours basis with the pressures recorded in a recorder strapped to the patient. This allows for a more physiological study since the assessment is performed with the patient's urine instead of an infusion at an unphysiological rate; and at a natural environment instead of a threatening laboratory setup. It is more sensitive in diagnosing detrussor instability. Up to 50% of "stable bladders" diagnosed on standard infusion urodynamic studies can be shown to have unstable contractions when tested with ambulatory urodynamics. The contractions can also be correlated to stress events which the patient can indicate on the recorder.

7. Sphincter electromyography

The activity of the motor units of the urethral sphincters can be studied in relation to the storage and voiding phases of micturition. During storage, there is a steady increase in the activity as the bladder fills. When voiding commences, all activities cease. In detrussor-sphincter dyssynergia, the motor units are not silent during voiding.

The EMG can be studied by surface electrodes (the overall activity of the pelvic floor is monitored), anal plug electrode or by needle electrodes. Assuming that the sphincters and the pelvic floor muscles act synchronously, activity of the anal sphincter reflects that of the urethric sphincters. Anal plug electrodes are electrodes mounted on an hour-glass anal plug that is inserted into the anal canal and the anal sphincters EMG recorded. With needle electrodes, the anal sphincter or the urethric sphincters are punctured. There are 2 types of needle electrodes. Concentric needle electrodes records a motor unit (muscle fibers supplied by a motor neurone) while a single-fibre electrode records activity of a single motor fibre.

8. Electrophysiological assessment

Neuronal integrity can be assessed by electrophysiological tests. The sacral spinal reflexes and nerve conduction studies can be performed using stimulating and recording electrodes. The latency period is

noted. Somatic pathways (using the pudendal nerve - dorsal nerve of the penis, or posterior tibial nerve) or autonomic pathway can be studied (catheter-mounted electrode placed to stimulate the afferents of the bladder neck).

Sensory evoked potentials can be employed to test the spinal pathways. The latency period between peripheral stimulation and the recorded cerebral evoked potentials is studied. Any prolongation would indicate disruption of the spino-cerebral pathways.

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6.16 TERMINOLOGY IN TRANSPLANT SURGERY

Types of Graft

Autograft - transplanted tissue taken from another site of the body eg. skin grafts, live fibular graft.

Isograft - grafts taken from genetically identical twins.

Allograft - grafts from individual who is genetically dissimiliar to the recipient but is of the same species as the recipient eg. kidney, liver, pancreas, heart, lung.

Xenograft - the donor and recipient are of different species eg. porcine skin, Hancock porcine heart valve

Site of Transplant

Orthotopically - replacing the diseased organ in its original site eg. liver transplant

Heterotopically - transplanted organ is placed at another site eg. kidney transplant where the donor kidney is placed in the pelvis

Types of Immune Response (Rejection)

Hyperacute -

rejection occurs within minutes of perfusion. Mediated by antibodies formed by previous sensitisation. Removal of donor organ necessary

Accelerated Rejection -

mediated by cellular immunity; similiar to acute rejection except more severe and occur within first few days

Acute Rejection -

variable in severity and often delayed to 3rd or 4th week with immunosuppressive therapy.

Chronic Rejection -

occurs more than 6 months or usually many years after transplantation. Characterised by obliteration of the vascular tree. Important to exclude recurrent disease and cyclosporin toxicity

MATCHING THE DONOR AND RECIPIENT

Blood Group Matching

Mandatory to have ABO compatibility for solid organ transplantation. These antigens are expressed in most tissue cells. While compatibility is acceptable, absolute matching gives better result.

The rhesus factor is expressed only in red blood cells and is hence not clinically important; they can be ignored in routine practice.

Major Histocompatibility Complex (HLA) Matching

This complex is located on chromosome 6. They encode the class I, II and III proteins.

Class I molecules - HLA -A, -B, -C. These antigens are targets for the graft rejection reaction. Each individual has two of each antigens. These glycoprotein antigens are nearly ubiquitous, though very little on the red cells. HLA -C does not seem to play an important role in organ matching. The advantage of matching 3 or 4 of the HLA -A and HLA -B antigens does not seem to confer significant clinical results as compared to matching only 2 antigens.

Class II molecules - antigens (HLA -DR, -DP and -DQ) that are present mainly on the surface of B lymphocytes, macrophages and dendritic cells. They are important for antigen presentation and hence in initiating the rejection reaction. Matching of these antigens gives considerable advantage over matches for one or no DR antigens. The mixed lymphocyte reaction identifies the D region incompatibilities functionally.

Class III molecules - chemically heterogenous; includes complement components C2, C4.

* When all 6 antigens of the HLA -A, -B and - DR are matched, there is an improvement of 20% in survival at one year. Recent studies has shown that HLA -A matching contributes less than HLA -B and -DR matching to this clinical advantage.

* Certain combinations of HLA -A, -B and - DR occur more commonly in the population (eg. HLA A1, B8 and DR3); hence matching of HLA antigens between unrelated individuals can be a partial reality.

* The current usage of tissue typing is relevant in cases of living-related donation. There is less acceptance that it should be a basis of allocating cadaveric kidneys; time-based priority should be the basis i.e. those who are earlier in the waiting list should be given priority.

* The effect of tissue matching is more important in repeated transplantation than in the first graft. With present immunosuppressive therapy, tissue matching in first graft has declined in importance.

* A positive crossmatch at the time of transplant has different connotation compared to a previous positive but current negative crossmatch. In the latter situation, successful transplant can be carried out without prejudice. However this applies to first grafts; those who are sensitised by the loss of a previous graft, this finding may be significant.

* The importance of tissue matching in cardiac and pancreatic transplant is even less understood compared to renal transplant; in liver transplant, matching is normally not attempted given the critical clinical situation.

* Complete HLA identity is important for the success for bone marrow transplantation; techniques of T-cell depletion has not prevent clinical significant rejection.

Basis of tissue typing -

The donor lymphocytes are separated from heparinised whole blood or from a lymph node. The cells are then exposed to sera with antibodies of known HLA antigens. The cytotoxic effect is then assessed by adding eosin which is taken up by dead cells.

It is also possible to screen the recipient's serum for anti-HLA antibodies

Augmented crossmatch techniques -

more sensitive than standard technique but its role is only in the complicated and sensitised recipients of repeated transplants

Flow Cytometry :

Detects immunoglobulins bound to the surface of the lymphocytes by measuring the binding of added fluoresceinated anti-Ig antibodies to the lymphocytes after exposure to the recipient's serum.

Anti-Globulin Lymphocytotoxic Crossmatch :

Anti-human globulin is incubated with the serum and lymphocytes before adding rabbit complement; in this way, low titres of antibody binding to lymphocytes can be detected.

Long - Term Problems of Transplant

1. Induction of Malignancy
2. Opportunistic Infections, Severe Sepsis
3. Recurrent Primary Disease Affecting Graft
4. Chronic Rejection and Re-Transplantation

*** most of the problems are related to immunosuppressive therapy**

IMMUNOSUPPRESSION

Drugs

Cyclosporin

* *standard immunosuppressive agent*
* *natural peptide found in fungi*

action - inhibits early stages of lymphocytic proliferation by an unknown mechanism and the synthesis of a variety of lymphokines by activated T-lymphocytes.

side-effects - nephrotoxicity which is reversible; hence when used in renal transplant, may mimic acute rejection and chronic rejection (chronic interstitial fibrosis with tubular atrophy).

Azathioprine

* *derivative of 6-mercaptopurine*
* *metabolised in the liver to 6-mercaptopurine*

action - inhibits DNA and RNA synthesis; can also block interleukin-2 production.

side-effects - myelotoxicity affecting mainly the leucocytes

hair loss in higher dose

drug interaction - allopurinol interferes with its breakdown and can lead to an accumulation of the active metabolites.

Corticosteroids

action - anti-inflammatory action alters the effector phases of rejection; hence high doses are used in treating acute rejection; also inhibit interleukin-1 and thence prevent T-lymphocyte proliferation and alter lymphocytic response to antigen.

side-effects - refer to textbooks where they are well-described.

Antilymphocyte Preparations (ALG)

1. Polyclonal

* *horse, goat or rabbit sera sensitised to human lymphocytes injected into the animals. The sera is purified and the antibody preparation absorbed onto red cells and platelets to remove those antibodies cross-reacting with these cell lines.*

action - acts by eliminating circulating T-lymphocytes.

side-effects - problem of non-standardisation

2. Monoclonal

* *one available commercially : OKT3*

action - action directed at CD-3 antigen on T-lymphocytes which act as a transmitter of signal from the T cell receptor to initiate intracellular activation; hence the lymphocytes become functionally blind.

side-effects - release of tumour necrosis factor from lysed lymphocytes is manifested as fever, chills, rigors and general malaise after the first doses. This is best treated by pre-treatment doses of anti- histamines and high dose corticosteroid.

FK506

* *macrolide antibiotic*
* *clinically more effective that cyclosporin in liver transplant;*
* *improved results in renal transplant not proven*

action - similar to cyclosporin

side-effect - nephro- and neurotoxicity

Total Lymphoid Irradiation

Experimental. Nine weeks of irradiation followed by early post-irradiation transplant. May still require supportive immunosuppression with the above drugs, though in some studies all medications were withdrawn successfully.

Photophoresis

Experimental. Involves psoralen sensitised ultra-violet irradiation of peripheral blood leucocytes causing cell death. May be effective in graft-vs-host reaction of bone marrow transplant.

CLINICAL REGIME

Aim

to provide adequate prevention of graft rejection without compromising host defence against viral, bacterial and fungal infections; with minimal side effects.

Induction (one of 6 suggested regimes)

High dose cyclosporin

High dose steroid / low dose azathioprine

Low dose steroid / high dose azathioprine

Cyclosporin and steriod

Triple therapy : cyclosporin + steroid + azathioprine

Quadruple therapy : triple therapy + ALG

* some centres do not start cyclosporin until diuresis started in renal transplant recipients, because of the nephrotoxic effect.
* most centres use triple therapy so as to reduce the side-effects of each drug.
* quadruple therapy mainly for sensitised and regraft patients i.e. high risk transplant situation.
* Azathioprine and prednisolone is still used for those who cannot afford cyclosporin and for those HLA-identical living related transplant.

Maintenance

Azathioprine and prednisolone

* prednisolone dose usually reduced after three months to 5-15 mg/day
* steroid withdrawal may be indicated in children and diabetic patients
* cyclosporin usually withdrawn from maintenance because of long-term effect on renal function, particularly progressive interstitial fibrosis.
* Low-dose maintenance cyclosporin is an alternative but costly.

Treatment of Acute Rejection

High dose steroid mainstay of treatment

Addition of ALG

Plasmapheresis

* high dose steroid can be administered orally or intravenously

* ALG (OKT3) can be added when steroid appear to be failing or as first line

* plasmapheresis is only useful if rejection reaction is mostly vascular i.e. the main contribution is from humoral immunity

ORGAN PRESERVATION

* warm ischaemic injury is due to the depletion of ATP stores and failure of oxidative phosphorylation which are needed for maintainance of the Na-K pump. When the pump fails, there will be inflow of Na ions resulting in cellular swelling and the "no-reflow" phenomenon with revascularisation. Associated anaerobic glycolysis with resulting acidosis will also cause the activation of lysosomal enzymes.

* organ preservation can be effected by pulsatile machine perfusion with a protein-based solution or by hypothermic flushing followed by simple cold storage. The former is cumbersome and the latter method is more widely practised.

Euro-Collins Solution

- prevent loss of intracellular ions : low Na high K concentration

- prevent intracellular swelling : hyperosmolar solution with impermeable solutes (mannitol)

- buffering of the acidosis : phosphates and HCO

University of Wisconsin Solution

- lactobionate, raffinose and hydroxyethyl starch instead of mannitol because mannitol can be metabolised

- adenosine added for ATP synthesis

- **glutathione as free radical scavenger**
- **allopurinol to inhibit xanthine oxidase and the generation of free radicals**
- **magnesium and dexamethasone as membrane stabilising agents**

* using UW solution, liver, heart can be preserved upto 30 hours compared to 6 hours for Euro-Collin solution; similarly kidney grafts can be preserved upto 72 hours instead of 48 hours.

* if the warm ischaemic time during organ recovery is more than 5 mins, the kidney should be transplanted within 8 hours

RESULTS OF ORGAN TRANSPLANT

	1-year survival
Kidney	85%
Liver	75%
Heart	75%
Pancreas	50%
Heart and Lung	60%

6.17 HAEMOSTASIS IN SURGERY

Phases of Coagulation

Vascular Phase

- reflex vasoconstriction

Platelet Phase

- adhesion and aggregation of platelets

Coagulation Phase

- clotting cascade involving plasma factors resulting in a stable clot

Control of coagulation

1. fibrinolytic system limits clotting to local site of injury; activated by fibrin
2. negative feedback mechanism by fibrin inhibiting activation of fibrinogen by thrombin
3. normally, intravascular coagulation prevented by smooth endothelium which are also coated with prostacyclin

Coagulation Dysfunction

PLATELET

Decrease In Numbers (Thrombocytopenia)

- drugs and chemicals
- viral infection
- hereditary thrombocytopenia

- bone marrow pathology (infiltration)
- increased destruction (hypersplenism)
- autoimmune (IgG, IgM)
- idiopathic
- dilutional (massive blood transfusion)

* **If thrombocytopenia is due to poor platelet production or dilutional effect, then platelets transfusion will help. Platelet transfusion is best given fresh because stored platelets loses its function quickly. Usually given just before surgery and perioperatively.**
* **If thrombocytopenia is due to peripheral destruction, platelet infusion may not reliably raised circulating platelet count. Specific treatment such as steroids or plasmapheresis will be required in addition to replacement.**

Poor Function

- hereditary (von Willebrand's disease, thromboasthenia)
- chronic liver disease, renal failure
- idiopathic
- aspirin

CLOTTING FACTORS

Deficiency

- hereditary (eg. haemophilia)
- poor liver function
- anti-coagulant drugs
- consumption coagulopathy (DIVC)
- dilutional (massive blood transfusion)

Inhibition

- heparin

Assessment of Coagulopathy

Bleeding Time

- *screening test for blood vessel and platelet abnormalities*

Platelet Count

Prothrombin Time (PT)

- *assess extrinsic pathway*

performed by adding brain thromboplastin to plasma

Partial Prothrombin Time (PTT)

- *assess intrinsic pathway*

performed by contact activation of factor XII with kaolin

Assays For Fibrin Degradation Products

- *assess for intravascular coagulation (DIVC)*

anti-fibrinogen antibodies or the newer assays using monoclonal antibodies are used to detect the degradation products of cross-linked fibrin

Reptilase Time

- *exclude heparin effect in cases of prolonged PT/PTT*

using snake venom which act directly on fibrinogen to form fibrin; hence not influenced by heparin as it does not depend on thrombin for its activation of fibrinogen

- **prolonged PT is usually due to deficiency of coagulation factors secondary to coumarins, vit K deficiency, liver disease or DIVC, Fresh frozen plasma and vit K will usually correct the problem**
- **when PTT is prolonged, a specific cause should be sought such as hereditary factor deficiencies**
- **thrombotest is specially designed to assess the effect of anti- vit K therapy**

Others

- Platelet function tests

- Immunoglobulin assays for autoimmune pathology eg. IgM, IgG for autoimmune thrombocytopenia

MANAGEMENT OF SURGICAL BLEEDING

General Measures

1. Tamponade - pressure dressings

2. Correct medical causes of coagulopathy

3. Transfusion of platelets or clotting factors

4. Specific treatment - steroids, plasmapheresis

Surgical Haemostasis

1. Diathermy

2. Direct sutures

3. Haemostatic agents

   gelatin sponge
   cellulose
   fibrin glue
   thrombin powder
   calcium alginate

* **gelatin, cellulose and collagen act by physical stimulation of the platelet aggregation and coagulation cascade; good for minor venous ooze but not for major bleeding from arteries.**
* **calcium alginate swabs on contact with blood release calcium in exchange for sodium and thence stimulating platelet activation and clotting.**

4. Ligation of feeding vessels eg. ligation of internal iliac arteries for pelvic bleeding (if done bilaterally can cause impotence in males).

5. Removal of source of bleeding eg. cystectomy for bleeding radiation cystitis, nephrectomy for bleeding Ca kidney and caesarian hysterectomy for post-partum haemorrhage, gastrectomy for bleeding peptic ulcers.

6. Endoscopic haemostasis

   - laser, cryoprobe or heater probe for bleeding peptic ulcers

   - injection of adrenaline for bleeding peptic ulcer

   - sclerotherapy for bleeding varices

Interventional Radiology

1. Selective arterial embolisation with gelfoam, spring coil, muscle

2. Regional perfusion of drugs eg. thrombovar or pitressin into oesophageal varices

Systemic Therapy

1. Intravenous vasopressin / desmopressin/ somatostatin for bleeding oesophageal varices

2. Aprotinin

3. Epsilon aminocaproic acid

* **vasopressin cause vasoconstriction to splanchnic arterioles and reduction in venous portal pressure; can cause coronary arterial vasoconstriction and is**

contraindicated in ischaemic heart disease.

- desmopressin is a synthetic analogue of vasopressin which has little vasoconstrictor action but acts by causing von Willebrand factor to move from intracytoplasmic stores to the luminal surface of endothelial cells which then promotes platelet aggregation (von Willebrand factor is necessary for normal platelet function).
- aprotinin inhibits serine protease inhibitor including urokinase; in high doses 50% reduction in postoperative bleeding in cardiac surgery has been reported.
- epsilon aminocaproic acid competitively inhibits the activation of plasminogen to plasmin; contraindicated in patients with atherosclerosis because of possibility of widespread thrombosis causing myocardial infarction or cerebrovascular accidents.

Others

Alum (10%) bladder washout for haematuria

Formalin (1%) instillation into bladder

Irradiation for bleeding bladder tumour or kidney carcinoma

- alum washout can result in systemic absorption causing aluminium toxicity.
- formalin has been reported to cause massive bladder mucosal sloughing and necrosis resulting in fatality.

6.18 MINIMAL ACCESS SURGERY

Definition

Surgery in which the trauma of access is minimised.

Advantages

1. Early return to normal activities
2. Less postoperative pain
3. Better cosmesis
4. Shorter hospital stay / day surgery basis
5. Less morbidity eg. less adhesion after laparoscopic laparotomy, decreased incidence of wound infections, early mobilisation and hence less respiratory complications

Disadvantages

1. Requires specialised training even for surgeons experienced in conventional surgery
2. Expensive equipments for initial setup and recurrent high expenditure if disposable instruments are used
3. More trained assistance required in operating the scopes and other instrumentations
4. Increased complications in certain procedures eg. common bile duct injury during laparoscopic cholecystectomy

LAPAROSCOPIC SURGERY

Scope

It is estimated that upto 90% of all conventional surgery can be performed laparoscopically.

Contraindications

1. Severe cardiopulmonary disease
2. Adhesions from previous surgery
3. Acute inflammation of target organ
4. Grossly distended bowel from intestinal obstruction
5. Presence of aortic aneurysm

Complications

1. Pneumothorax and its associated morbidity
2. Injuries during insertion of trocars (bowel, bladder, blood vessels)
3. Complications related to the procedure eg. injury to common bile duct during cholecystectomy, injury to adjacent organs, bleeding

Safety Practices

1. Insert a Ryle's tube and decompress the stomach
2. Catheterise the bladder
3. Place patient in the Trendelenberg position
4. Careful positioning and padding of the patient

5. Drop test - a drop of water is placed at the trocar site of the Veres' needle after it is inserted and then the abdominal wall lifted. The negative intra-abdominal pressure created will suck the water in if the needle is correctly placed.

6. Palmer's test - a syringe filled with water is used to aspirate at the insertion point. A nil or bloody aspirate means adhesions present. A cloudy aspirate indicates bowel puncture. If air bubbles aspirated, the site is clear of adhesions and bowel

Shortcoming And Future Improvement

1. Loss of stereoscopic vision and depth perception
2. Limited dexterity aggravated by awkward fulcrum movement
3. Lack of sensory input to the operator
4. Reduced field of view (tunnel vision)

Improvement in instrumentation may see the introduction of rotating tip cameras, 3D television systems with digital enhancement, flexible graspers and dissectors, wider range of more versatile endostapling devices and laparoscopic endosonography.

Improvement in imaging and technology may allow for virtual reality images, robotic arms to control camera and telepresence surgery.

Modifications of the technique has been attempted - substituting gas infusion with laparolift technique, retroperitoneal surgery using the Gaur's balloon.

Clinical Application

GENERAL SURGERY

Cholecystectomy, appendicetomy, herniorrhaphy, vagotomy, colectomy, gastrectomy, splenectomy, adhesiolysis.

UROLOGY

Pelvic lymphadenectomy, varicocelectomy, nephrectomy, ureterolithotomy, pyelotomy, pelvic floor repair, vesical myotomy.

OBSTETRICS AND GYNAECOLOGY

Ovarian cystectomy, fulguration of endometriosis, ectopic pregnancy, harvesting of ovum, tubal ligation.

ENDOSCOPIC SURGERY

The forerunner of laparoscopic surgery. The first laparoscopy was performed in 1903 using a cystoscope. Success with endoscopic surgery provided the impetus for the advancement of minimal access surgery.

System Improvements

1. Lens technology with fibreoptics light transmission
2. Smaller calibre scopes to minimise trauma of insertion
3. Introduction of flexible scopes
4. Smaller working instruments - laser fibre technology allows for smaller working channel and hence smaller calibre scopes

Clinical Application

UROLOGY

Transurethral resection of prostate and bladder tumour, optical urethrotomy, urethral stenting, ureteroscopy and lithotripsy, percutaneous nephrolithotomy and lithotripsy / pyelotomy, insertion and removal of ureteric stents.

GASTROINTESTINAL SURGERY

Injection of varices, haemostasis of bleeding peptic ulcers, polypectomy, laser fulgurisation of advanced obstructing tumours, dilatation of strictures, endostenting, percutaneous gastrostomy, endoscopic mucosal resection for early tumours.

ERCP with sphincterotomy, extraction of common bile duct stones, nasobiliary drainage, biliary duct stenting and mechanical lithotripsy.

THORACIC SURGERY

Thoracoscopy and mediastinoscopy. Wedge resection, lung biopsy, pleurodesis, sympathectomy, oesophagectomy.

ARTHROSCOPIC SURGERY

Joint debridement, removal of loose bodies, repair of ligaments, menisectomy.

OTOLARYNGOLOGY

Fibreoptic endoscopic sinus surgery.

OBSTETRICS & GYNAECOLOGY

Hysteroscopic resection of polyps, septum, fibroids.

OTHERS

Other aspects of minimal access surgery would include procedures such as microdiscectomy.

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